The Biologic and Economic Assessment of Pest Management in Rice

J. Ples Spradley
Extension Pesticide Assessment Specialist
Cooperative Extension Service
University of Arkansas

Tony E. Windham
Extension Economist - Management
Cooperative Extension Service
University of Arkansas

A Special Funded Project of the United States Department of Agriculture, National Agricultural Pesticide Impact Assessment Program, Document Number 2-CA-95

THE BIOLOGIC AND ECONOMIC ASSESSMENT OF PEST MANAGEMENT IN RICE

J. Ples Spradley
Extension Pesticide Assessment Specialist
Cooperative Extension Service
University of Arkansas

Tony E. Windham
Extension Economist - Management
Cooperative Extension Service
University of Arkansas

A Special funded Project of the United States Department of Agriculture,
National Agricultural Pesticide Impact Assessment Program
Document Number 2-CA-95

ACKNOWLEDGEMENTS

Very special thanks is given to the rice growers in Arkansas, California, Louisiana, and Texas who completed and mailed in their surveys. This project would not have been possible without their cooperation and input.

The following list contains the names of individuals who contributed their time and expertise towards this project. Their contributions and cooperation are greatly appreciated and a special thanks is extended to them.

Arkansas -	Dr. Ford L. Baldwin, Dr. John Bernhardt, Craig Brown, Dr. Gary L. Cloud, Gwen Fletcher, Dr. Charles B. Guy, Steve Hall, Dr. Ronnie S. Helms, Dr. Donald R. Johnson, Dr. Terry Lavy, Dr. Fleet N. Lee, Ronald L. Rainey, Dr. John F. Robinson, Nathan A. Slaton, Janie Taylor, and Dr. William C. Yearian
California -	Dr. D. Marlin Brandon, Dr. Larry D. Godfrey, Dr. James E. Hill, Rick Melnicoe, Dr. Jeffery J. Oster, and Steven C. Scardaci
Louisiana -	Dr. Jack L. Bagent, Dr. Mary L. Grodner, Dr. Clayton Hollier, Dr. Dennis R. Ring, Dr. Dearl Sanders, and Dr. Paul Seilhan
Texas -	Dr. Bastiaan M. Drees, Dr. Rodney Holloway, Dr. Arlen Klosterboer, Dr. Joseph P. Krausz, and Dr. M.O. Way
Mississippi -	Dr. Ted Miller and E. Ruth Morgan
Washington, DC -	Dr. Dennis D. Kopp, Dr. Craig D. Osteen, Dr. Leonard P. Gianessi

This publication is dedicated in memory of Paul Seilhan, Extension Rice Specialist, Louisiana State University.

The mention of products and trade names in this publication does not signify that these products are endorsed or approved to the exclusion of comparable products.

CONTENTS

LIST OF TABLES

APPENDIX

EXECUTIVE SUMMARY

This publication assesses the various biologic and economic factors associated with pest control in United States rice production. Information on the pesticides used, the targeted pests, application rates, acres treated, and the use of non-chemical pest control measures were provided by a survey of rice growers in Arkansas, California, Louisiana, and Texas. Extension Service and University rice specialists in these four states were also surveyed to determine yield impacts of losing certain pesticides with and without suitable alternatives.

Combining survey data and incorporating information from other sources allowed a comprehensive assessment of the benefits of pesticide use on rice and identification of pesticides and pest management techniques which are critical for U.S. rice production. In addition, alternative pest control measures and their relative effectiveness are discussed.

Rice production in the United States began on the East Coast in the 1600s. By the early 1900s the rice industry became concentrated in the mid-south states and in the Sacramento Valley of California. Today there are six primary rice producing states (Arkansas, California, Louisiana, Mississippi, Missouri, and Texas). A small amount of rice is also grown in Florida. Arkansas, Louisiana, California, and Texas accounted for 88% of the total rice acres planted in 1993 and 89% of the total production for that year.

Pest management in rice focuses on the control of weeds, diseases, and insects. In general, the most economically damaging pest problems in rice are weeds followed by disease and insects. However, in certain situations diseases and/or insect pests can produce significant crop loss. Rice pests not only reduce yield but also reduce the crop quality. Certain weed seeds and insect damage reduce the quality of the harvested rice and result in discounts in the price paid to growers.

The results of the grower survey indicate the highest use pesticides (propanil, molinate, 2,4-D, benomyl, methyl parathion, and carbofuran) account for approximately 70 percent of the total pounds of pesticide active ingredient applied to U.S. rice acreage each year. The surveyed rice specialists indicated that there were effective alternatives for four of these six highest use pesticides. The specialists stated there were not adequate alternatives for benomyl (fungicide) and carbofuran (insecticide). Benomyl is the only fungicide which provides adequate control of the disease rice blast (*Pyricularia grisea*) which can cause yield losses as high as 60-90 percent. Granular carbofuran is the only registered insecticide formulation for rice water weevil (*Lissorhoptrus oryzophilus*) control which is a significant problem for rice production, especially in areas where rice is water seeded (i.e., California and Louisiana).

The registration for use on rice for both benomyl and carbofuran is in jeopardy due to potential human and wildlife risks. Benomyl use on rice may be canceled due to residues on rice seed hulls that are subject to Section 409 of the Federal Food, Drug, and Cosmetic Act (FFDCA) and affected by the "Delaney Clause". (However, at the time of this writing, EPA is proposing to eliminate the Section 409 tolerance as unnecessary, so that the Delaney Clause would not affect benomyl use on rice because residues do not exceed the Section 408 tolerance when the seed hulls are processed into ready-to-eat animal feed.) Carbofuran is suspected of causing bird mortalities and scheduled to lose its registration on rice after the 1996 growing season. The economic assessment on the effects of losing these two pesticides indicates that although the overall effects appear to be small, certain rice producing regions and individual farmers could be severely impacted. The rice specialists also responded that yield reductions due to the loss of specific pesticides would increase in subsequent years due to a buildup of pest populations.

Both growers and specialists indicated that alternatives to pesticides are used extensively in rice production. The most prevalent non-chemical pest control method is the use flood water to control primarily weeds. Other non-chemical pest control strategies used by rice growers include: resistant/tolerant varieties, fertility management, seeding rates, planting dates, and crop rotation. In addition to non-chemical pest management, rice specialists and growers are examining strategies that use existing pesticides in new ways. Reduced rates of pesticides coupled with a higher level of crop/pest management, better implementation of existing pest thresholds,

and adjustments in the timing of pesticide applications have all been used to enhance the control of rice pests with relative success.

The use of alternative strategies, both chemical and non-chemical, is an indication of the widespread use of integrated pest management (IPM) in rice production. IPM is an integral part of educational efforts and pest control recommendations made by Extension personnel and University researchers. Rice production guidelines published by the various state Extension Services emphasize IPM when planning pest control strategies. These guidelines contain detailed information on crop scouting and the economic thresholds for the more damaging pests.

The continued availability of effective rice pesticides and the use of other pest management practices are critical to maintaining rice yields and quality. The loss of one or more critical rice pesticides (i.e., benomyl and carbofuran) could drastically affect rice production in the United States and force many rice growers out of business. More research is needed to develop additional management methods for rice pests, especially those that are effectively controlled by only one pesticide.

INTRODUCTION

Rice (*Oryza sativa*) is a valuable food and processing crop grown on an average (1990-1994) of just over three million acres annually in the United States. It is estimated that rice production in the United States has an average annual farm value of approximately $1.1 billion (11).

Both chemical and non-chemical pest control strategies are needed to manage the various pests of rice. Although pesticides play an essential part in rice production, both farmers and nonfarmers are concerned with the impact these products may have on the environment. In response to the need for pest management information for various agricultural commodities, the U.S. Department of Agriculture established the National Agricultural Pesticide Impact Assessment Program (NAPIAP) in 1976. A primary objective of NAPIAP is to conduct pesticide use surveys on economically important commodities.

The primary objective of the present study was to ascertain the biologic and economic factors related to rice pest control. Efficacy, economics, availability of alternatives, effects on yield and quality due to use of alternatives, and actual usage data, as they relate to rice pest control, are addressed. The impact of losing certain rice pesticides due to possible adverse human and/or environmental effects is also discussed. This report identifies pesticides and other pest control strategies that are critical to rice production in the United States. In some cases this report indicates a need for additional research in certain areas of rice pest control or points out alternatives that are not being fully utilized.

To assess the factors involved with rice pest control, both growers and rice specialists (University and Cooperative Extension Service personnel) were surveyed in Arkansas, Louisiana, California, and Texas relative to rice pests and their management. Growers were asked to specify their pest control practices and the rice specialists were asked about alternative pest control practices, the effects of losing specific pesticides, and the resulting effects on rice yield and quality. The responses have been tabulated and are discussed in the body of this report.

Historically, rice production in the U.S. began in the Carolinas in the late 1600's. For various reasons, including hurricanes and The Civil War, rice production moved westward in the late 1800's (8). The rice industry became concentrated in two distinct regions of the U.S. where ideal rice growing conditions are present (i.e., abundant water supplies for the high water requirements of rice, relatively flat, fertile soil, and a long, warm growing season). These areas are found primarily in the mid-south states and the Sacramento Valley of central California. Although both these regions are suited to rice production there are some significant differences in the growing conditions of the two areas resulting in crop and pest management practices that are similar in many cases but very different in others.

There are six primary rice producing states: Arkansas, Louisiana, California, Texas, Mississippi, and Missouri. A small amount of rice is grown in Florida. Of these six, Arkansas, Louisiana, California, and Texas accounted for eighty-eight percent (88%) of the total rice acres planted in 1993 and eighty-nine percent (89%) of the total production for that year (6).

Conditions that favor rice production also influence the pests and their management. The flooded and humid environment of a rice field can be very conducive for weed growth and the development of diseases. Certain insect pests also thrive in the aquatic environment. Pest problems in rice are complicated because ground based cultivation and pesticide application equipment are rarely used. Flooded soil conditions for most of the growing season prohibit use of ground equipment. Ground equipment is used to prepare the fields for planting, make many of the preplant pesticide applications, and often for planting the rice seed. Once the rice emerges and the irrigation regimen begins, pesticide and fertilizer applications are made primarily by aircraft.

Pest management in rice focuses on the control of weeds, diseases, and insects. Generally speaking, the most severe (i.e., most economically damaging) pest problems in rice are weeds followed by diseases and insects.

PRODUCTION PRACTICES

An understanding of rice production is required in order to discuss the pest management practices. Generally, rice production begins with seedbed preparation, usually in the summer or

fall before planting. The stubble from the previous crop is tilled or rolled to increase soil contact and decomposition rate of plant material. These cultural practices can help reduce overwintering forms of certain rice pathogens. In the spring the final seedbed is prepared with tillage and land smoothing. Optimal planting dates range from mid-March to mid-May depending on the region and the environmental conditions.

For dry seeding, the seed is planted either with a grain drill or broadcast on the soil surface and buried with light tillage. Once the field is planted the levees for holding the flood water are marked (based on differences in field topography), constructed, seeded and levee gates are installed. Under favorable environmental conditions the seed will germinate without added moisture. With drier conditions the field must be flushed with water to ensure good germination. Rice emergence is usually 7 to 10 days after planting.

Concurrent with rice emergence is weed emergence. Weeds are most easily controlled when they are small. Therefore, a critical time for weed control is the period from rice emergence to the establishment of the permanent flood (approximately three to six weeks after emergence). Usually 1-2 herbicide applications are made during this period if weather conditions permit. An insecticide application for control of rice water weevil (*Lissorhoptrus oryzophilus*) is sometimes required although this application is usually made after the establishment of the permanent flood. Once the rice plants reach 6-8 inches in height the field is flooded to a depth of 3-6 inches. The field is normally fertilized immediately preceding the establishment of the permanent flood (1).

Early season production practices are somewhat different for water seeded rice. Once the final seedbed is prepared the levees are marked, constructed and the flood waters applied. The rice seed (usually presprouted) is then broadcast into the water by airplane. In some situations the water is drained after a short period to allow the rice seedlings to become rooted to the soil. This management method is termed "pinpoint flooding." Once the seedlings attach to the soil the field is reflooded. In other water seeded situations, the field is never drained after planting. The flooding depth may be shallow (2") immediately after seeding but is gradually increased as the rice plants grow, or held continuously at 4 to 5 inches deep (9). These types of water management are known as "continuous flooding."

Regardless of the planting method, the rice plant initially grows vegetatively and produces numerous tillers. As the growing season progresses the rice plant goes into reproductive growth. Reproductive growth begins with panicle initiation, then culms elongate, there is usually a decline in tiller numbers (this sometime occurs before panicle initiation), and the flag leaf emerges followed by booting, heading, and flowering. These reproductive stages usually occur over a period of approximately 30 days. Following flowering, the grain ripening stage for rice takes approximately 30-45 days depending on the variety and weather. During the latter part of the ripening stage the field is drained of flood water in preparation for harvest.

Rice grain is harvested with the hulls intact and is referred to as rough rice. The moisture content of rough rice must be reduced from about 17%-23% moisture content at harvest to 12% before it can be safely stored. To prevent deterioration, the drying must begin within 24 hours of harvest. Therefore, rough rice is moved immediately from the field to commercial or on-farm drying and storage facilities. After drying, the rice is milled. The milling process involves the removal of foreign matter and the rice hulls. Unless the rice is sold as brown rice (the hull removed but bran layers intact), it is milled further to produce white rice, then sized, graded and then routed into marketing channels for domestic use or export.

In certain areas of Texas and Louisiana, the harvested plants are left undisturbed and allowed to retiller and produce a second crop of rice during the same growing season. This is known as the "ratoon" crop. Regrowth of the rice plant is stimulated with additional fertilizer and specific water management practices after the first harvest. Pesticide use on the ratoon crop is limited (usually applications of broadleaf herbicides). Good pest management is essential with the first crop to help alleviate pest problems with the ratoon crop (13).

PEST MANAGEMENT

Rice pests include weeds, diseases, insects/invertebrates, and certain physiological disorders (i.e., straighthead). Virtually all rice growers

employ both chemical and non-chemical measures to control pests in rice, thus an integrated approach for controlling pests (integrated pest management (IPM)).

IPM is the practice of using all suitable techniques and methods in as compatible a manner as possible to maintain pest populations at levels below those causing economic injury. This includes the use of cultural practices, mechanical controls, other crop management practices, and pesticides. The emphasis is on anticipating (i.e., scouting for) and preventing pest and other production problems. IPM is an integral part of the educational efforts and pest control recommendations made by Extension personnel and University researchers. Rice production guidelines published by the various state Extension Services emphasize IPM when planning pest control strategies. These guidelines contain detailed information on crop scouting and the economic thresholds for the more damaging pests.

In the 1970s a computer program was developed by University of Arkansas rice specialists and researchers to help rice growers precisely time mid-season nitrogen applications. Known as "DD50", the program is based on the use of temperature data to predict rice development. The program has been developed into an IPM tool that now assists growers with 28 management decisions based on growth stage, including not only nitrogen application but also herbicide application, and critical times to scout for diseases and insects (12).

The Cooperative Extension Services and Universities in other rice growing states have also developed computer programs designed to help rice growers with their pest management decisions.

Cultural practices used by rice growers to reduce pest problems include variety selection, planting dates, seeding rates, fertility management, rotation, and the reduction in overwintering sites for the rice water weevil by removal of levee vegetation. The cultural practice of reflooding rice fields after harvest and maintaining the flood during the winter months is used not only for pest control but also for wildlife management. Flooded fields during the winter months attract migrating ducks and other waterfowl. Ducks can enhance red rice (*Oryza sativa*) and other broadleaf weed control by feeding on the seed that remains on the soil surface after the rice harvest. Therefore, ducks are provided with feeding and resting sites while performing a form of weed management (10). Mechanical weed control, in the form of water management, is used on virtually all rice acres.

Weed control is a primary area of concern to rice growers because there are a number of economically detrimental rice weeds. Many of these are difficult to control because they are grasses in the same family as rice. In addition, mechanical cultivation is nearly impossible due to the flooded field conditions. A grass weed in a grass crop such as rice complicates the weed control strategies because a herbicide used to control grass weeds may also injure the rice crop. Even with this limitation there are a number of herbicides that are used effectively on rice. In addition, there are non-chemical approaches to controlling weeds in rice, with the most prevalent being water.

Virtually all the rice produced in the U.S. is eventually grown under flooded field conditions. A water depth of typically 2-6 inches is maintained throughout most of the growing season which helps prevent weed seeds from germinating or kills small weeds due to oxygen depletion in the flooded soils. The rice may be water seeded to take advantage of the weed suppression provided by the flood water. Another option is drill seeding a dry rice field, applying herbicide(s), and then flooding for additional weed control.

The use of flooding also influences the disease and insect control in rice. The typically warm and moist conditions found in a rice field are conducive to disease development. Resistant/tolerant varieties, water management, measures to reduce disease inoculum carryover, and fungicides are all used to control rice diseases. Resistant/tolerant varieties are an excellent way to reduce disease pressure, but a few of the disease causing organisms, such as *Pyricularia grisea* (causes rice blast), have shown the ability to quickly develop new races which can infect previously resistant rice. Therefore, rice varieties must continually be developed to maintain the disease resistance/tolerance characteristics. Resistance/tolerance is not available for controlling certain diseases of rice and therefore fungicides are an important component of the disease management program.

Relatively few insects are serious pests in rice although the damage produced by these insects can be significant. One of the major insect pests of rice is the rice water weevil. This insect can cause serious yield losses when not controlled. One of the complicating factors in controlling this insect is that flood water allows the insect to produce large numbers of larvae which seriously damage the rice plant by feeding on the roots.

One option for controlling the rice water weevil larvae is to drain the rice field and allow it to thoroughly dry thereby reducing the number of larvae. In many instances (especially water seeded rice) draining and drying the field is not possible or economically feasible. (Specialist note: In Texas, the method of planting does not determine if fields can be drained for water weevil control.) In these cases, the use of an insecticide is critical for controlling rice water weevil. The only effective insecticide for controlling rice water weevil is granular carbofuran which is scheduled to lose its registration on rice because of its toxicity to birds resulting in suspected bird mortalities due to its use and misuse.

METHODS

The grower surveys were conducted with only minor changes using methods described by Dillman (7). Rice producers (see Table 1) from Arkansas, Louisiana, and California were randomly selected using grower lists from various sources. The list of Arkansas rice growers was obtained from county Extension grower lists. Louisiana rice growers were selected from lists provided by rice grower associations. California rice growers were selected from a list provided (for cost) by Data Harvest, Inc., a private company. Data Harvest, Inc. compiled the list of growers based on a database developed from the required pesticide use recordkeeping in California. In Texas the survey questionnaire was sent to all identifiable rice growers from lists provided by Texas rice grower associations.

Each selected grower was mailed a survey questionnaire concerning their 1993 rice crop (the Arkansas growers reported on their 1992 rice crop). The questionnaires were 11 to 18 pages in length printed in a small page (6" x 8 1/4") format and contained 35 to 43 questions. The California survey had fewer questions because questions on fungicide use were not included due to the lack of registered fungicides for California rice. A copy of a sample survey questionnaire is included as Appendix A.

Although there was some variation among states, the survey mailouts proceeded as follows: three weeks after the initial mailout a postcard reminder was mailed to those rice producers who had not responded. If, after six weeks, the grower had still not responded, a second questionnaire was sent.

For Arkansas, Louisiana, and California the completed surveys were returned to the Cooperative Extension Service, University of Arkansas (UACES) for data entry and analysis. Data entry for the Texas surveys was done at the Texas Agricultural Extension Service in Beaumont, Texas and the database was submitted to UACES. Summaries of the data were made by UACES personnel. The results of the grower surveys, by state, are included as Appendix B.

Rice specialist surveys were conducted to obtain information that could not be reliably obtained from growers. The requested information dealt with the alternatives for specific rice pesticides and the effects on yield if certain pesticides were "lost" and alternatives were used or not used. This information was critical for an economic assessment of pesticide use on rice. The rice specialist surveys were sent to the weed scientists, entomologists, agronomists, and plant pathologists with rice responsibilities in each of the participating states. Summaries of the specialist surveys were done by UACES. A copy of a sample specialist survey is included as Appendix C. Copies of the completed specialist surveys are included as Appendix D.

RESULTS

The response rate for the grower surveys ranged from a high of 59% (Arkansas) to a low of 15% (Texas) with an overall average of 28% (Table 1). Table 2 shows that the surveyed acreage of 182,989 acres for the four states represents approximately 7% of the total rice acreage (2,685,000 acres) for the states.

The percentage of rice acres planted by drill seeding, water seeding, and dry broadcast were 44%, 35%, and 21% respectively for the four states (Table 2). The highest percentage of drill seeded

and dry broadcast planted acres were in Arkansas and Texas. The majority of rice acres in California and Louisiana were planted by water seeding.

Although the acreage varies significantly, Arkansas, Louisiana, and Texas grow essentially the same varieties. The leading variety, Lemont, was grown on approximately 17% of the rice acres in these three states (Table 3). California's rice varieties center around the "M" series. The varieties M202, M201, M401, and M204 accounted for 82% of the rice acreage planted in California.

Rice yields for the states were reported in various measurements. In Arkansas, most growers reported yields in bushels (45 pounds per bushel) per acre (Table 4). In California and Texas, yields were reported in hundredweights per acre. In Louisiana, most growers reported yields as bushels per acre although 20% reported yields as barrels (162 pounds per barrel) per acre. When all yield information was converted to pounds per acre the average yields were 5805, 8750, 4480, and 6840 pounds per acre for Arkansas (1992 data), California, Louisiana, and Texas respectively in 1993. The overall average yield for the four states, as determined by the grower survey was 6560 pounds per acre. The National Agricultural Statistics Service (NASS) reported the following yields for Arkansas (1992), California, Louisiana and Texas in 1993 were 5500, 8300, 4550, and 5400 pounds per acre respectively (6). The overall average yield per acre in 1993 (1992 for Arkansas), as reported by NASS, was 5750 pounds.

Growers in Louisiana were asked to not include their ratoon crop yield when reporting their average yield per acre. Due to an omission on the survey questionnaire Texas growers were not instructed to omit their ratoon crop yields when reporting their average yield per acre. This may explain some of the differences in the average yields reported by Louisiana and Texas growers versus the yields reported by NASS. Average yields per acre as reported by NASS include ratoon crop yields.

Table 1. Numbers of Rice Growers Surveyed, Number Responding, and Response Rate by Participating State.

State	Growers Surveyed	Growers Responding	Response Rate
Arkansas	500	297	59%
California	315	92	29%
Louisiana	254	76	30%
Texas	1,300	197	15%
TOTAL	2,369	662	28%

Table 2. Total Rice Acres by State (1993*), Total Surveyed Rice Acres, and Planting Methods Used.

State	Total Rice Acres*	Total Rice Acres Reported in Survey	Surveyed Acreage as % of Total Acres	Percentage of Total Acres (Survey) Planted by the Following Methods:		
				Drill Seeded	Water Seeded	Dry Broadcast
AR	1,400,000	73,475	5.2	68	2	29
CA	440,000	39,382	9.0	3	97	0
LA	545,000	21,841	4.0	7	78	16
TX	300,000	48,291	16.1	56	15	29
TOTAL	2,685,000	182,989	6.8	43.6	35.0	21.2

*Acres listed are for the 1993 growing season except for Arkansas which is based on 1992 acreage (Crop Production and Prospective Plantings, March 1994. National Agricultural Statistics Service, USDA). The Arkansas grower survey was conducted in 1992. The grower surveys in the other states were conducted in 1993.

Table 3. Rice Varieties Planted by State, Total Acres Planted to Each Variety, and Percentage of Total Acres Planted to Each Variety (1993 for LA, CA, TX; 1992 for AR).

Variety	Percentage of Acres by State				Total Acres Planted (AR,LA,CA,TX)	Percentage of Total Acres Surveyed
	AR	LA	CA	TX		
Lemont	19.2	12.1	—	29.5	30,996	16.9
M202	—	—	56.2	—	22,133	12.1
Gulfmont	0.4	0.7	—	40.9	20,198	11.0
Katy	20.3	—	—	1.1	15,446	8.4
Newbonnet	19.6	1.6	—	0.5	14,991	8.2
Alan	15.8	0.3	—	—	11,675	6.4
Maybelle	0.9	16.6	—	14.4	11,241	6.1
Mars	5.9	18.9	—	—	8,463	4.6
Millie	7.8	—	—	—	5,731	3.1
M201	—	—	11.8	—	4,647	2.5
M401	—	—	7.7	—	3,032	1.7
Jackson	0.3	5.3	—	2.9	2,776	1.5
M204	—	—	6.5	—	2,560	1.4

Table 4. Average Yield Per Acre by State as Reported by Surveyed Growers (1993*), and Average Statewide Yield as Reported by the National Agricultural Statistics Service.

State	Average Yield Per Acre (Survey):			Avg. Yield/Acre Survey (Pounds)	Avg. Yield/Acre NASS* (Pounds)
	Bushels	Barrels	Hundredweight		
AR	129	—	—	5805	5500
CA	—	—	87.5	8750	8300
LA	98.9 (80% of respondents)	27.7 (20% of respondents)	—	4480	4550
TX	—	—	68.4	6840	5400
			Overall Avg. Yield	6560	5750

*Annual Crop Production 1993 Summary, January 1994 (Arkansas data is from 1992). National Agricultural Statistics Service, USDA.

WEED CONTROL

Weed control is a primary area of concern for rice producers. Crop production estimates from the Cooperative Extension Service, University of Arkansas indicate rice producers spend more per acre for weed control than for insect or disease control. These estimates indicate that typically 10-15% of the per acre expenses for rice production are for weed control and do not include irrigation costs which can be considered as part of the weed control strategy.

Weeds compete with rice for light, nutrients, water, and other growth requirements. There are three primary ways that weeds cause losses in rice: 1) yield reduction due to competition, 2) losses in quality due to weed seeds in the milled rice, and 3) increased costs due to losses in efficiency and the costs of control measures. Smith et al. (14) in 1977 reported the total estimated direct losses from weeds and expenditures for their control in rice were $290 million annually in the United States. With the increase in rice acres and inflation since 1977, current losses are probably in excess of $300 million.

An excellent review paper on losses due to weeds and weed density interference thresholds was published by R. J. Smith in 1988 (15). In the paper Smith, from research conducted primarily in Arkansas, found that among the grass weeds

in density experiments, red rice (*Oryza sativa*) reduced rice grain yields the most followed by barnyardgrass (*Echinochloa crusgalli*), bearded sprangletop (*Leptochloa fasicularis*), and broadleaf signalgrass (*Brachiaria platyphylla*). In broadleaf/aquatic weed density experiments, hemp sesbania (*Sesbania exaltata*) reduced rice grain yields the most followed by northern jointvetch (*Aeschynomene virginica*), ducksalad (*Heteranthera limosa*), dayflower (*Commelina communis* or *C. diffusa*), and eclipta (*Eclipta prostrata*). Barnyardgrass, broadleaf signalgrass, and ducksalad interference was greatest during early season, whereas eclipta, hemp sesbania, northern jointvetch, red rice, and spreading dayflower caused greater interference during mid to late-season.

Besides competing with the rice plant for nutrients and water, weeds can also impact rice quality by contributing weed seeds to the harvested rice. Losses in quality due to weed seeds in the milled rice is a significant problem for rice growers especially in the mid-south. Rice contaminated with weed seeds receives a discounted price at the elevator. Hemp sesbania, northern jointvetch, morningglories (*Ipomea spp.*), and red rice all have seeds which are similar in size to rice. Removing the weed seeds after harvesting is a difficult and costly process. Therefore, weed control strategies aimed at these weeds is critical to prevent them from reaching maturity and producing seed.

The potential losses in both yield and quality by certain densities of selected weed species infesting rice in Arkansas are summarized in Table 5.

The economics of weed management can also negatively impact the profit potential for rice production. The use of certain relatively inexpensive herbicides, such as 2,4-D and propanil, has been restricted in some states due to drift problems on susceptible crops. The use restrictions often require that more expensive herbicides must be substituted to obtain the necessary weed control. This topic will be discussed in more detail in the analysis of the rice weed specialist surveys. Weeds can also affect harvesting efficiency by increasing the amount of vegetation moving through the combine which decreases the efficiency of the equipment.

More than 30 weed species were identified by growers and rice specialists as significant problems in rice. The weeds and their relative rankings by growers and by rice specialists/researchers are listed in Tables 6 and 7. Rice weeds may be divided into three categories – the grass weed complex, the aquatic weed complex, and the broadleaf-sedge weed complex.

Table 5. Effect of Weed Competition on Rice Yield and Quality.

Weed Species	Density (Plants/ft^2)	Potential Yield Loss (%)	Potential Quality Loss[1] (%)
Barnyardgrass	5	50	4
Bearded sprangletop	10	40	4
Broadleaf signalgrass	15	40	4
Red rice	2	50	10
Ducksalad	100	30	2
Hemp sesbania	1	50	8
Northern jointvetch	2	50	8
Morningglories (on levees)	2	10	8
Eclipta	1	20	3
Spreading dayflower	2	15	3

[1] Includes reduction in milling yield and/or grade as applicable. Source: Rice Production Handbook, MP192, 1990. Cooperative Extension Service, University of Arkansas.

Table 6. Grower Ranking of Weeds Causing the Greatest Monetary Loss to the 1993 (1992 for AR) Rice Crop. Numbers represent the percentage of growers in AR, LA, TX, and CA listing the weed.

Weed	% of Growers Listing Each Weed				Overall Percentage*	Overall Ranking**
	AR	CA	LA	TX		
Echinochloa sp. (Barnyardgrass, Watergrass, Junglerice, Red Top)	36	40	29	34	26.7	1
Oryza sativa (Red Rice)	17	—	23	14	10.7	2
Leptochloa sp. (Bearded, Red, & Amazon Sprangletop)	10	9	3	11	6.8	3
Ipomea sp. (Morningglory)	14	—	—	3	5.1	4
Cyperus sp. (Yellow & Purple Nutsedge, Smallflower Umbrellaplant, Flatsedge)	5	14	4	6	5.1	4
Sesbania exaltata (Hemp Sesbania, Coffeebean)	12	—	3	4	5.0	5
Aeschynomene sp. (Northern Jointvetch, Curly Indigo, Indian Jointvetch)	10	—	8	1	4.2	6
Heteranthera limosa (Ducksalad)	6	—	10	—	2.7	7
Brachiaria platyphylla (Broadleaf Signalgrass)	3	—	—	7	2.4	8
Ammannia coccinea (Redstem)	5	2	1	1	2.3	9
Alternanthera philoxeroides (Alligatorweed)	—	—	11	1	1.4	10
Polygonum sp. (Pale & Pennsylvania Smartweed)	4	—	—	—	1.2	11
Commelina sp. (Dayflower, Water Parsley)	1	—	—	4	1.1	12
Scirpus sp. (Roughseed & Ricefield Bulrush)	—	8	—	—	1.1	12
Caperonia palustrus (Texasweed, Mexicanweed)	—	—	4	2	0.8	13
Paspalum sp. (Water Bermuda)	—	—	4	—	0.5	14
Sagittaria sp. (Common, Gregg's & California Arrowhead)	—	4	—	—	0.5	14
Sorghum halepense (Johnsongrass)	1	—	—	1	0.3	15
Xanthium strumarium (Cocklebur)	1	—	—	—	0.3	15
Eleocharis sp. (Spikerush)	—	—	—	2	0.3	15
Algae	—	2	—	—	0.3	15
Melochia corchorifolia (Redweed)	—	—	—	4	0.3	15
Panicum dichotomiflorum (Fall Panicum)	1	—	—	—	0.2	16
Physalis angulata (Groundcherry)	1	—	—	—	0.2	16
Bacopa rotundifolia (Water Hyssop)	1	—	—	—	0.2	16
Digitaria sp. (Southern & Smooth Crabgrass)	1	—	—	—	0.2	16
Fimbristylis sp. (Hoorahgrass, Fan Sedge)	—	—	—	1	0.2	16
Pontederia cordata (Pickerelweed)	—	—	1	—	0.2	16
Setaria sp. (Foxtail)	—	—	1	—	0.2	16
Sphenoclea zeylandica (Gooseweed)	—	—	1	—	0.2	16
Bromus sp. (Bromegrass)	—	1	—	—	0.2	16

* The overall percentage is based on the total number of growers listing a weed as compared to the total number of growers responding to the question.

** The weed listed as causing the greatest monetary loss in the 1993 (1992 for AR) rice crop is ranked number 1, the next most economically damaging weed is ranked number 2, etc.

Table 7. Specialist Ranking of Weeds Causing the Greatest Monetary Loss to the Annual Rice Crop. Numbers represent the average ranking of a weed by the various rice weed specialists in the given state.

Weed	Weeds as Ranked by the State Rice Specialists*				Overall Ranking**
	AR	CA	LA	TX	
Echinochloa sp. (Barnyardgrass, Watergrass, Junglerice, Red Top)	1	1	1	1	1
Oryza sativa (Red Rice)	2	—	2	2	2
Leptochloa sp. (Bearded, Red, & Amazon Sprangletop)	5	4	8	3	3
Cyperus sp. (Yellow & Purple Nutsedge, Smallflower Umbrellaplant, Flatsedge)	8	2	6	4	4
Sesbania exaltata (Hemp Sesbania, Coffeebean)	4	—	7	8	5
Ipomea sp. (Morningglory)	3	—	—	9	6
Aeschynomene sp. (Northern Jointvetch, Curly Indigo, Indian Jointvetch)	6	—	5	10	7
Brachiaria platyphylla (Broadleaf Signalgrass)	7	—	—	5	8
Ammannia coccinea (Redstem)	9	6	8	10	9
Heteranthera limosa (Ducksalad)	10	—	4	—	10
Alternanthera philoxeroides (Alligatorweed)	—	—	3	10	11
Scirpus sp. (Roughseed & Ricefield Bulrush)	—	2	—	—	12
Caperonia palustrus (Texasweed, Mexicanweed)	—	—	8	7	13
Paspalum sp. (Water Bermuda)	—	—	6	—	14
Algae	—	6	—	—	15
Sagittaria sp. (Common, Gregg's & California Arrowhead)	—	6	—	—	15
Pontederia cordata (Pickerelweed)	—	—	8	—	16
Setaria sp. (Foxtail)	—	—	8	—	16
Sphenoclea zeylandica (Gooseweed)	—	—	8	—	16
Commelina sp. (Dayflower, Water Parsley)	—	—	—	6	17
Polygonum sp. (Pale & Pennsylvania Smartweed)	11	—	—	—	18
Eleocharis sp. (Spikerush)	—	—	—	9	19
Melochia corchorifolia (Redweed)	—	—	—	9	19
Sorghum halepense (Johnsongrass)	—	—	—	10	20
Fimbristylis sp. (Hoorahgrass)	—	—	—	10	20

* The weed listed as causing the greatest monetary loss for an average year is ranked number 1, the next most economically damaging weed is ranked number 2, etc.

** Overall rankings were achieved by: 1) multiplying a state's acreage in rice production by 10 for a pest ranking of 1 within that state, 9 for 2,..., and 1 for 10 or more and 2) adding the resulting numbers by pest from all reporting states together, and then 3) taking the resulting pest scores and numerically ranking the highest pest score as number 1, the second highest as 2, etc.

Because of the aquatic environment and the fact that rice is either broadcast seeded or planted in narrow drilled rows, there is no opportunity for mechanical methods of weed control after the crop is planted. For this reason, most rice fields are infested with representatives from at least two and often all three weed categories.

The grass weed complex is composed primarily of barnyardgrass/watergrass/junglerice/red top (*Echinochloa spp.*), sprangletop (*Leptochloa spp.*), red rice (*Oryza sativa*), broadleaf signalgrass (*Brachiaria platyphylla*), crabgrass (*Digitaria spp.*), and fall panicum (*Panicum dichotomiflorum*). Although there were differences among states, growers and rice specialists listed the grass weeds barnyardgrass, red rice, and sprangletop as the weeds causing the greatest monetary loss in rice (Tables 6 and 7). The two herbicides used on the greatest percentage of rice acres in Arkansas, Louisiana, California (molinate only), and Texas are propanil and molinate (Table 8). These are used primarily for grass control and indicate that grass weeds are the main focus of weed control strategies in rice.

The aquatic weed complex consists primarily of ducksalad, redstem (*Ammannia spp.*), algae (various genera), arrowhead (*Sagittaria spp.*), alligatorweed (*Alternanthera philoxeroides*), pickerelweed (*Pontederia cordata*), and spikerush (*Eleocharis spp.*). Water management and 2,4-D are the primary control measures for the aquatic weeds. The herbicides thiobencarb and bensulfuron can be added to propanil where severe infestations occur or in areas where 2,4-D cannot be used. In California, propanil is rarely used and bensulfuron is the primary herbicide for controlling aquatic weeds.

The broadleaf/sedge complex includes hemp sesbania, northern jointvetch, annual morningglories, dayflower, smartweed (*Polygonum lapathifolium*), gooseweed (*Sphenoclea zeylandica*), Texasweed (*Caperonia palustrus*), and several sedges (*Cyperus spp.*). The broadleaf/sedge weed complex tends to be more prevalent on the poorly drained, heavy clay soils of the Mississippi River Delta (1).

Because mechanical cultivation is not an option, water and herbicides are the primary management tools for controlling weeds in rice. Maintaining flood water on the rice field during the growing season helps prevent the germination and development of many weed species. Sowing rice directly into a flooded field (i.e., water seeding), also takes advantage of the weed control provided by flooding. Water seeding can help eliminate or reduce some early season herbicide applications which can be important if herbicide sensitive crops are grown near the rice (i.e., cotton and certain horticultural crops). Water seeding is also a useful practice in suppressing red rice infestations.

Water seeding can have it's drawbacks though. State Extension Service recommendations call for higher seeding rates (30% or more) when water seeding. Water seeding can result in reduced or uneven stands if the rice seed "drifts" or is "buried" by wind and wave action. Besides the higher initial seed cost, maintaining the flood water for a longer period in water seeded rice can also result in higher irrigation costs. Nevertheless, water seeding is a valuable practice and was utilized on approximately 36% of the acreage surveyed, with the majority of California (97%) and Louisiana (78%) rice acres being planted by this method.

Drill seeding into a dry seed bed is generally more conducive to establishing a good stand of rice at seeding rates lower than those required for water seeding (does not apply to California's fine textured "heavy" soils, personal communication, James E. Hill), but herbicides are critical for controlling early weed infestations which can have a major impact on the yield potential for a given field.

Surveyed producers were asked a number of questions concerning their weed control practices. The herbicides the growers reported using, the total acres treated by state, the total acres treated in all four states, the average rate per acre, and the total pounds of active ingredient are contained in Table 8.

The five pesticides used on the largest percentage of the reported rice acres (propanil, molinate, 2,4-D, bensulfuron, and thiobencarb) were used in each of the four states (Table 8). These herbicides accounted for 85 percent of the total pounds of

herbicide active ingredient applied. Of the remaining ten herbicides only copper sulfate and MCPA were used in California. Copper sulfate is used for both algae and tadpole shrimp control in California. Although growers were asked to differentiate between these uses of copper sulfate there may be some overlap. In addition, copper sulfate is often applied to limited areas of rice fields, such as field borders, where the algae problems are worst. Therefore the total pounds of copper sulfate applied as an algaecide may be lower than indicated by the survey.

Approximately 72 percent of the total rice acres in the four states received applications of propanil, making it the most prevalently used rice herbicide and the one with the largest total pounds of active ingredient applied (5,722,673 pounds a.i.). Molinate (a carbamate herbicide) was used on approximately 47 percent of the total rice acres and had the second highest total pounds of active ingredient applied (3,396,238 pounds a.i.). Thiobencarb (another carbamate herbicide) was used on approximately 14 percent of the total rice acres with a total of 1,028,351 pounds of active ingredient applied. Therefore, 61 percent of the total rice acres received a carbamate herbicide application and a total of 4,964,589 pounds of active ingredient were applied. Propanil, molinate and thiobencarb are all used primarily for grass control.

The plant growth regulators 2,4-D and MCPA, used primarily for broadleaf control, were applied to approximately 25 percent of the total rice acres in the four states. The relatively lower application rates for these two herbicides resulted in 521,016 total pounds of active ingredient applied to the total acres in the four states. Triclopyr was used on approximately 6 percent of the total acres under Section 18 emergency exemptions in Arkansas, Louisiana, and Texas. In 1995 triclopyr received federal registration for use on rice. Accordingly, the use of triclopyr should increase because it tends to have less drift problems than 2,4-D when applied near susceptible crops and it's weed control spectrum is similar to 2,4-D.

Quinclorac is another herbicide that is increasing in use due to recent federal registration. In 1993 approximately 10 percent of the total rice acres in the four states were treated with the herbicide. Quinclorac has excellent activity on barnyardgrass, crabgrass, and broadleaf signalgrass and has the added advantage of being one of the few rice herbicides labeled for a preemergence or delayed preemergence application. This allows more flexibility in the weed control programs of rice growers. Personal communication with rice specialists in Arkansas indicate the use of quinclorac on rice has increased since 1993.

Approximately 20 percent of the total rice acres in the four states (83 percent of the California rice acres) received an application of bensulfuron. Bensulfuron is used primarily for sedge and aquatic broadleaf weed control. The extensive use of bensulfuron in California is due to it's relatively large spectrum of weeds controlled, low application rates, and environmental compatibility. However, most of the weeds in California are developing resistance to bensulfuron causing a rapid return to the phenoxy herbicides, MCPA and 2,4-D (personal communication, James E. Hill).

The total pounds of herbicide active ingredient applied to rice acres in Arkansas, Louisiana, California, and Texas was 13,153,946 pounds.

The rice growers were also asked to list any non-chemical measures or strategies used to help control weeds. Table 9 lists the non-chemical methods of weed control provided by growers, the acres treated, and the percentage of acres treated for the four states. Individual state reports (see Appendix B) provide the targeted pests for each control measure and the estimated degree of control. Growers reported that the non-chemical weed control method used on the highest percentage of rice acres was water management (7% of the total acres in the four states). Although not indicated by the results of this survey, virtually all rice acres are grown under flooded conditions which is a form of weed control.

Other strategies listed by the growers were: crop rotation, hand weeding, use of the bioherbicide "Collego", and minimum/no-till. Crop rotation was listed by Arkansas growers for controlling northern jointvetch and weeds in general. The growers reported that the control provided by crop rotation was "fair" (see individual state report in Appendix B).

Crop rotation is also used to help control red rice in some of the southern states (personal communication with Arkansas rice specialists). A rotational crop of soybeans allows the use of herbicides for controlling red rice that are not registered for use on rice. Another recommended alternative control method for red rice is flooding the harvested rice field during the winter, when possible, to encourage the presence of waterfowl which feed on the red rice seed that is at the soil surface, thereby reducing the seed numbers. Crayfish also feed on red rice seeds and sprouts during the winter.

In California the growers reported using crop rotation to help control sedges, broadleaves, and all weeds in general. The California growers reported good to excellent control of the targeted weeds using crop rotation.

A small number of Arkansas growers reported using Collego, a biological herbicide with the fungus *Colletotrichum gloeosporioides* as the active ingredient which is pathogenic to the weed, northern jointvetch. Minimum/no-till production practices were also listed by Arkansas growers as a means of helping control various broadleaf weeds. The growers reported the quality of control provided by minimum/no-till was "good".

Rice weed specialists were surveyed to assess the potential yield impact of losing certain herbicides for use on rice. The specialists were asked to list the alternatives that would be used if a particular herbicide was "lost" (see Tables 10 and 11). Loss of a herbicide could be due to adverse human or environmental effects, Delaney Clause (FFDCA) restrictions, or other reasons resulting in cancellation of it's registration on rice. The specialists also estimated the yield impact if the alternatives for the herbicide were used or not used. In addition, the specialists were asked to estimate the impact of losing groups of herbicides (i.e., carbamates and growth regulators), or losing all herbicides (Tables 12 and 13). The individual state's specialist surveys are contained in Appendix D.

The alternatives used in the place of lost herbicides are not simply a matter of substituting one herbicide for another. In many cases it takes a tank mixture of different herbicides or multiple applications of different herbicides to achieve the same level of weed control provided by the "lost" herbicide (depending on the overall weed spectrum of a given rice field). An example is given in Table 10 for the alternatives listed for propanil. Nine different herbicides and water management were listed by the rice specialists as alternatives to propanil. Propanil has activity on grasses and certain broadleaves. If propanil could no longer be used it would take, in most cases, more than one herbicide to provide the same level of weed control. The specialists indicated that for many of the "lost" herbicides the situation would be similar (i.e., more than a single herbicide or cultural practice would be required to replace a lost herbicide).

The largest negative yield impact from losing specific herbicides and using the available alternatives was for propanil, molinate, 2,4-D, and bensulfuron. It should be noted that the California rice weed specialist indicated that using bensulfuron as an alternative to 2,4-D or MCPA could actually lead to a yield increase of approximately 10 percent. Rice weed specialists also indicated that using alternatives for thiobencarb or fenoxaprop could also increase yields by 10 to 15 percent.

For the highest use herbicides (propanil, molinate, 2,4-D, bensulfuron, thiobencarb, and quinclorac) the estimated yield impact of losing these pesticides without the availability of the listed alternatives would range from zero yield reduction (2,4-D) to 95 percent yield reduction (propanil). The specialists indicated that there were chemical alternatives for all of the rice herbicides except for copper sulfate (Table 10). Therefore, in Table 10 the column that indicates yield impact by using the alternatives is a better estimation of the yield effects if specific herbicides were no longer used on rice. The rice specialists were also queried concerning any secondary effects from using the alternatives for specific herbicides or groups or herbicides. Their comments are given in Tables 11 and 13.

The economic impacts of losing certain herbicides used on rice is discussed in more detail in the economic assessment section of this report.

Table 8. Acres Treated for Each Herbicide, Average Rate (Pounds of Active Ingredient) Per Acre, and Total Pounds of Active Ingredient (Grower Survey).

Herbicide	Total Acres Treated by State ( ) = % of Acres Treated				Total Acres Treated ( ) = % of Total Acres Treated (AR,LA,CA,TX)	Avg. Rate (lbs ai) Per Acre	Total Pounds Active Ingredient
	AR	CA	LA	TX			
propanil	1,205,000 (>94)*	3,080 (0.7)	315,010 (57.8)	311,100 (100)	1,834,190 (71.5)	3.12	5,722,673
molinate	379,400 (29.6)	348,040 (79.1)	290,485 (53.3)	178,500 (59.5)	1,196,425 (46.6)	3.29	3,936,238
2,4-D	320,040 (25.0)	20,680 (4.7)	232,170 (42.6)	22,500 (7.5)	595,390 (23.2)	0.82	488,220
bensulfuron	16,800 (1.3)	366,960 (83.4)	111,180 (20.4)	11,700 (3.9)	506,640 (19.8)	0.053	26,852
thiobencarb	114,800 (9.0)	80,080 (18.2)	11,445 (2.1)	154,500 (51.5)	360,825 (14.1)	2.85	1,028,351
quinclorac	162,400 (12.7)	—	35,425 (6.5)	60,900 (20.3)	258,725 (10.1)	0.37	95,728
pendimethalin	147,000 (11.5)	—	7,085 (1.3)	15,000 (5.0)	169,085 (6.6)	0.94	158,940
triclopyr	79,800 (6.2)	—	55,590 (10.2)	6,000 (2.0)	141,390 (5.5)	0.41	57,970
copper sulfate	—	126,720 (28.8)	—	4,800 (1.6)	131,520 (5.1)	10.9	1,433,568
bentazon	21,000 (1.6)	—	14,715 (2.7)	78,300 (26.1)	114,015 (4.4)	0.64	72,970
bromoxynil	95,200 (7.4)	—	—	—	95,200 (3.7)	0.26	24,752
acifluorfen	53,200 (4.2)	—	7,085 (1.3)	2,400 (0.8)	62,686 (2.4)	0.37	23,193
MCPA	—	50,160 (11.4)	—	4,500 (1.5)	54,660 (2.1)	0.60	32,796
fenoxaprop	44,800 (3.5)	—	—	2,400 (0.8)	47,200 (1.8)	0.12	5,664
glyphosate	—	—	44,690 (8.2)	—	44,690 (1.7)	1.03	46,031

*Arkansas rice specialists indicated that the 94 percent of acres treated with propanil, as reported by growers, is probably low.

Table 9. Acres Treated for Each Alternative Weed Control Practice by State, and Total Acres Treated (Grower Survey).

Alternative Weed Control Method	Total Acres Treated by State, ( )= % of Acres Treated				Acres Treated, ( ) = % of Total Acres Treated (AR,LA,CA,TX)
	AR	CA	LA	TX	
Water management*	53,760 (4.2)	42,680 (9.7)	33,790 (6.2)	49,500 (16.5)	179,730 (7.0)
Crop rotation	11,520 (0.9)	7,920 (1.8)	—	—	19,440 (0.8)
Hand weeding	5,120 (0.4)	—	17,440 (3.2)	—	22,560 (0.9)
Collego (Bioherbicide containing *Colletotrichum gloeosporioides*)	1,280 (0.1)	—	—	—	1,280 (0.05)
Cultural practices (not named)	—	10,560 (2.4)	—	1,800 (0.6)	12,360 (0.5)
Minimum/No-Till	10,240 (0.8)	—	—	—	10,240 (0.4)

*Although a limited number of growers indicated they used water management for weed control, virtually all rice acres are grown in flooded conditions which is a form of weed management.

Table 10. Individual Herbicides, Acreage Treated, Herbicide Use in Pounds of Active Ingredient, Alternative Treatments and Impact on Rice Yield With and Without Availability of Alternatives.

Herbicide	% of Total Rice Acres Treated (AR,LA,CA,TX)	Rice Acres Treated (AR,LA,CA,TX)	Alternatives, ( ) = No. of States Listing Alternative (Specialist/Researcher Survey)	Yield impact*	
				W/Alt.	W/O Alt.
propanil	71.5	1,834,190	molinate(4), quinclorac(3), thiobencarb(3), fenoxaprop(2), 2,4-D(2), bentazon(1), pendimethalin(1), triclopyr(1), acifluorfen(1), water management(1)	(-)5% to (-)40%	(-)30% to (-)95%
molinate	46.6	1,196,425	propanil(3), thiobencarb(3), quinclorac(3), fenoxaprop(3), pendimethalin(1), 2,4-D(1),	(-)5% to (-)30	(-)5% to (-)75%
2,4-D	23.2	595,390	triclopyr(3), propanil(2), acifluorfen(2), bensulfuron(2), quinclorac(1), bentazon(1), Hand Weeding(1)	(+)10% to (-)40%	0 to (-)60%
bensulfuron	19.8	506,640	2,4-D(3), triclopyr(3), bentazon(2), propanil(2), thiobencarb(1), acifluorfen(1), quinclorac(1), MCPA(1), Dry Seeding(1),	0 to (-)30%	(-)5% to (-)25%
thiobencarb	14.1	360,825	molinate(2), propanil(2), quinclorac(2), fenoxaprop(2), pendimethalin(1), 2,4-D(1), Deep Water(1)	(+)10% to (-)20%	(-)20% to (-)25%
quinclorac	10.1	258,725	propanil(3), molinate(3), thiobencarb(2), pendimethalin(2)	0 to (-)10%	(-)15% to (-)80%
pendimethalin	6.6	169,085	propanil(2), quinclorac(2), thiobencarb(2), molinate(1)	0 to (-)10%	(-)15% to (-)80%
triclopyr	5.5	141,390	2,4-D(3), bensulfuron(2), acifluorfen(1), quinclorac(1)	0 to (-)15%	(-)5% to (-)30%
copper sulfate	5.1	131,520	Drain Fields(1)	(-)5%	(-)5%
bentazon**	4.4	114,015	propanil(2), bensulfuron(2), triclopyr(2), 2,4-D(2), molinate(1),	0 to (-)5%	0 to (-)10%
bromoxynil	3.7	95,200	No Alternatives Listed	No Data	No Data
acifluorfen	2.4	62,685	triclopyr(3), 2,4-D(3), propanil(1), bensulfuron(1)	0 to (-)10%	(-)5% to (-)15%
MCPA	2.1	54,660	bensulfuron(1), 2,4-D(1), triclopyr(1)	(+)10% to 0	(-)5% to (-)10%
fenoxaprop	1.8	47,200	molinate(2), propanil(2), quinclorac(1), pendimethalin(1), thiobencarb(1)	(+)15% to (-)5%	(-)5% to (-)30%
glyphosate	1.7	44,690	No Alternatives Listed	No Data	No Data
paraquat	0.3	7,085	No Alternatives Listed	No Data	No Data

* Numbers listed are the range of estimates provided by the responding specialists.

** Bentazon has already lost its registration for use on California rice. Its loss was critical to the longevity of bensulfuron. Without it there has been rapid resistance development (personal communication, James E. Hill).

Table 11. Secondary Effects Due to Use of Alternatives for Specific Herbicides as Reported by Rice Specialists/Researchers.

Herbicide	Secondary Effects Due to Use of Alternatives*, ( )= Number of States Listing the Effect
propanil	Increased costs (2) Increased herbicide use - no single herbicide would serve as a substitute for propanil, all of the alternatives would require tank mixes or combinations (1). Cultural methods would help but would not be very effective (1). Quality loss, reduced harvest efficiency, greater disease and insect pressure (1). Yield impacts are all assumed if all other herbicides are available. If the list is shortened, numbers would change dramatically (1).
molinate	Thiobencarb (a listed alternative) has a narrow application window so grasses will escape (1). Thiobencarb is more injurious to rice (1). Increased costs (1). Molinate is the only salvage herbicide for big grass. Where a farmer gets good control early - no yield impact if molinate lost and alternatives used. However, if there is failure to control weeds early, loss can be 40% or greater without molinate (1). Thiobencarb residues in water are more troublesome (1). Using deep water for control will result in progressively increasing seed bank (1).
2,4-D	Increased costs (1) The big economic impact will not be yield loss but quality discounts from "black seeded" weeds i.e., hemp sesbania, northern jointvetch, smartweed, and morningglory species (1).
bensulfuron	Increase in sedges, rushes, and certain broadleaf weeds. Buildup of weeds to cause losses beyond 25% (i.e., sedges can be bad but it will take a while in absence of herbicide (bensulfuron) to build a seed bank (2). Injury due to phenoxys (a listed alternative) on rice (1) Injury due to drift from phenoxys on other crops (1)
thiobencarb	Using deep water for weed control will result in progressively increasing seed bank (1). Thiobencarb is the best sprangeltop herbicide and sprangletop is rapidly increasing (1). Fenoxaprop (a listed alternative) can injure rice (1). Would increase broadleaf herbicide use (1).
quinclorac	Increase in number of applications of different herbicides (1)
pendimethalin	Increased costs (1) Pendimethalin is one of the best control options for sprangletop (1).
MCPA	Alternative (bensulfuron) will result in rapid buildup of resistant weeds (1).
glyphosate	Glyphosate is used for ease of tillage operation with little or no impact on yield. No conservation tillage program in CA because of no drill seeding to speak of (1).

*Comments provided by specialists are listed verbatim.

Table 12. Rice Herbicide Groups, Acreage Treated, Herbicide Use in Pounds of Active Ingredient, Alternative Treatments and Impact on Rice Yield With and Without Availability of Alternatives.

Herbicide Group	% Total Rice Acres Treated (AR,LA, CA,TX)	Rice Acres Treated (AR,LA,CA,TX)	Herbicide Use (Thousands lbs ai)	Alternatives, ( ) = No. of States Listing Each Alternative (Specialist/Researcher Survey)	Yield Impact*	
					W/Alt.	W/O Alt.
Growth Regulators (2,4-D, MCPA, triclopyr)	30.9	791,440	578,986	bensulfuron(3), quinclorac(2), propanil(2), acifluorfen(1), Hand Weeding(1)	0 to (-)30%	(-)5% to (-)40%
Carbamates (molinate, thiobencarb)	60.7	1,557,250	4,964,589	propanil(4), quinclorac(3), fenoxaprop(2), pendimethalin(2), Deep Water(1)	0 to (-)50%	(-)20% to (-)60%
ALL HERBICIDES	219.1	5,619,725	13,158,410	Water Management(4), Drill Seeded Rice(1), Taller Varieties(1), Quit Farming(1)	(-)30% to (-)100%	(-)60% to (-)100%

*Numbers listed are the range of estimates provided by the responding specialists.

Table 13. Secondary Effects Due to Use of Alternatives for Specific Herbicide Groups as Reported by Specialists/Researchers.

Herbicide Group	Secondary Effects Due to Use of Alternatives*, ( )= Number of States Listing the Effect
Growth Regulators	Grain quality is lost, not yield. Will increase the use of other herbicides (1). Resistance will build but rice could still be grown if grass herbicides were available (1).
Carbamates	If residual herbicides are lost and a rescue treatment is needed for large grass the overall effect will be increased herbicide use (1). In the 1920's California almost went out of business with no herbicides for grass control. Yields would decrease over time as seed bank increased. End result would be "out of business" (1). Water management still accounts for 10-40% of our weed control in general, or 50-60% of red rice control (1).
ALL HERBICIDES	Yield and quality of decline (1). The problem is that cultural controls (deep water, etc.) will work until seed bank gets so heavy rice cannot be grown profitably. If all herbicides were lost growers would be out of business due to a lack of grass weed control (1).

*Comments provided by specialists are listed verbatim.

DISEASE CONTROL

Diseases can be a seriously limiting factor in the production of rice especially in the mid-south. Data from research tests suggest that rice diseases annually cause at least an average range of 12-15% loss in yield in the South. With present production costs and price of rice, this average yield loss translates into an average 33-40% loss in potential net return due to rice diseases (11). In California, rice diseases do not result in severe problems due to environmental conditions (i.e., less humidity and isolation from other rice growing regions). In fact, no rice fungicides are registered for use in California except for seed treatments.

Unfortunately, over the past decade many changes in rice production practices designed to attain maximum yields also have created conditions favorable for diseases. Some of these practices include increased nitrogen fertilization, widespread use of varieties very susceptible to sheath blight, shortened rotations, more dense plant canopies, and the decline of moldboard plowing in favor of shallow disking (13). Sound cultural practices, resistant/tolerant varieties, and chemical controls are all required to manage diseases effectively. Cultural practices for managing rice diseases include: applying the correct nitrogen rate uniformly; spreading the planting dates; planting more than one rice variety; management practices that prevent overly thick stands; destruction of crop residues; minimum or no-till practices; and crop rotation.

Seedling diseases of rice, caused by various soil and seed-borne fungi, can be a problem in certain situations. Cool temperatures, wet soil, and other conditions that delay seedling emergence contribute to rice seedling diseases. These diseases can result in reduced stands and weakened plants both of which can lead to additional problems during the growing season. Fungicide seed treatments can significantly reduce the levels of seedling diseases in rice. Growers reported using a number of seed treatments to protect against seedling diseases and to promote uniform rice emergence (Table 14).

Fungicide seed treatments were used on a minimum of 25 percent of the total rice acres in Arkansas, Louisiana, and Texas. The exact acreage planted with treated seed was difficult to determine because growers sometimes use more than one seed treatment. Carboxin was the fungicide seed treatment used on the majority of acres planted with treated seed. Gibberellic acid, a plant growth regulator, was used as a seed treatment on approximately 16 percent of the rice acres for the three states. Gibberellic acid promotes even stand emergence.

Sheath blight (*Rhizoctonia solani*) and blast (*Pyricularia grisea*), are the most prevalent and destructive diseases of rice in the United States.

Sheath blight is the most widespread rice disease in the mid-south growing regions. Both growers and rice disease specialists ranked sheath blight as the disease causing the greatest monetary loss in rice (Tables 15 and 16). Yield reductions due to sheath blight may be as high as 50-60% although the average annual loss is estimated to be in the range of 5-20% (11)

Table 14. Rice Seed Treatments, Percentage of Acres Planted with Treated Seed, and Total Acres Planted with Treated Seed (Grower Survey).

Seed Treatment	Percentage of Acres Planted with Treated Seed by State			Total Ac. Planted with Treated Seed (AR,LA,TX)	% of Total Rice Acres Planted with Treated Seed (AR,LA,TX)
	AR	LA	TX		
carboxin	18.8	6.3	63.8	45,966	25.1
gibberellic acid	26.6	—	20.0	29,166	15.9
mancozeb	3.5	8.0	7.0	7,731	4.2
zinc	—	—	14.3	6,886	3.8
metalaxyl	1.0	1.8	0.5	1,341	0.7
thiram	—	5.0	0.2	1,171	0.6
PCNB	0.6	—	0.2	583	0.3
TCMTD	0.3	—	—	200	0.1

Table 15. Grower Ranking of Diseases Causing the Greatest Monetary Loss to the 1993 (1992 for AR) Rice Crop. Numbers represent the percentage of growers listing the disease.

Disease	% of Growers Listing Each Disease, by State				Overall Percentage*	Overall Ranking**
	AR	CA	LA	TX		
Thanatephorus cucumeris (Rhizoctonia solani) (Sheath Blight)	47	1	37	50	38.8	1
Pyricularia grisea (Rice Blast)	24	—	22	18	18.4	2
Magnaporthe salvinii (Sclerotium oryzae) (Stem Rot)	1	25	—	3	6.1	3
Straighthead (physiological disorder)	2	—	11	2	3.1	4
Phytophthora sp., Pythium sp., Achyla sp. (Water Molds)	—	—	12	—	1.9	5
Gaumannomyces graminis (Black Sheath Rot)	—	—	—	3	1.5	6
Sphaerulina oryzina (Cercospora janseana) (Narrow Brown Leafspot)	—	—	1	4	1.3	7
Cochliobolus miyabeanus (Helminthosporium oryzae) (Brown Leafspot)	—	—	1	2	0.6	8
Tilletia barclayana (Kernel Smut)	1	—	—	1	0.4	9
Entyloma oryzae (Leaf Smut)	—	—	—	1	0.2	10
Xanthomonas campestris pv. oryzae (Bacterial Leaf Blight)	—	—	—	1	0.2	10

* The overall percentage is based on the total number of growers listing a disease as compared to the total number of growers responding to the question.

** The rice disease listed as causing the greatest monetary loss in the 1993 (1992 for AR) rice crop is ranked number one (1), the next most economically damaging disease is ranked number two (2), etc.

Table 16. Specialist Ranking of Diseases Causing the Greatest Monetary Loss to the Annual Rice Crop. Numbers represent the average ranking of a disease by the various rice disease specialists in each state.

Disease	Diseases as Ranked by the State's Rice Specialists*				Overall Ranking**
	AR	CA	LA	TX	
Thanatephorus cucumeris (Rhizoctonia solani) (Sheath Blight)	1	—	1	1	1
Pyricularia grisea (Rice Blast)	2	—	2	2	2
Magnaporthe salvinii (Sclerotium oryzae) (Stem Rot)	4	1	—	5	3
Straighthead	3	—	5	7	4
Cochliobolus miyabeanus (Helminthosporium oryzae) (Brown Leafspot)	5	—	6	7	5
Gaumannomyces graminis (Black Sheath Rot)	4	—	—	4	6
Tilletia barclayana (Kernel Smut)	4	—	—	6	7
Sphaerulina oryzina (Cercospora janseana) (Narrow Brown Leafspot)	—	—	4	3	8
Rhizoctonia oryzae-sativae (Sheath Spot)	—	2	—	—	9
Phytophthora sp., Pythium sp., Achyla sp. (Water Molds)	—	—	3	—	10
Entyloma oryzae (Leaf Smut)	—	—	—	7	11
Xanthomonas campestris pv. oryzae (Bacterial Leaf Blight)	—	—	—	8	12

* The rice disease listed as causing the greatest monetary loss for an average year is ranked number one (1), the next most economically damaging disease is ranked number two (2), etc.

** Overall rankings were achieved by: 1) multiplying a state's acreage in rice production by 10 for a pest ranking of 1 within that state, 9 for 2,..., and 1 for 10 or more and 2) totalling the resulting numbers by pest from all reporting states, and then 3) taking the resulting pest scores and numerically ranking the highest pest score as number 1, the second highest as 2, etc.

Factors favoring the development of sheath blight in rice fields include: the use of highly susceptible rice varieties; high nitrogen rates; early seeding dates and early maturing varieties; thick stands; short intervals between rotated crops; and increased disease development (*R. solani* is also a pathogen of soybeans) in irrigated soybeans, a rotational crop.

The sheath blight fungus overwinters primarily in the soil in the form of sclerotia which can persist in the soil for many years. When rice is flooded, sclerotia become buoyant and float to the water surface, come in contact with the rice stem and infect the outer sheath of the lower leaves. Environmental conditions favoring rapid development are hot daytime temperatures (85° to 90° F), damp weather, nighttime temperatures of 70° to 80° F, and high humidity (95%). High temperature combined with low humidity limits development of sheath blight in the upper rice canopy (12).

The environment within the rice canopy greatly influences the development of the sheath blight fungus. Once the canopy begins to close, the mycelia of the fungus grow out from the initial lesion near the water line and up the stem to the next leaf and eventually to the flag leaf and nearby plants. Horizontal spreading to surrounding plants results from contact of infected leaves.

Damage ranges from partial damage to a few of the lower leaves with little effect on grain development to premature desiccation of entire plants. The latter may cause lodging and affect grain development. Depending on the stage of panicle development at which the pathogen blocks the upward movement of plant solutions, grains may be almost mature or only partially filled. In very early sheath blight infections under environmental conditions favorable for disease development, many of the florets may be blank or contain only poorly developed grains. Such grains usually break up in the milling process. Thus, the disease can significantly reduce both yield and quality. Reduction in grain yields as high as 47 percent have been measured in research tests (12).

Practices which reduce sheath blight include: management of rice stubble to reduce inoculum carryover (i.e., rolling stubble to increase soil contact thereby speeding up the decomposition of inoculum or burning of rice stubble); selecting rice fields with the least history of sheath blight; selecting least susceptible rice varieties; avoiding thick stands and excessive nitrogen fertilization; scouting for sheath blight symptoms; and applying a fungicide when threshold levels are reached (12).

The relative susceptibility of southern U.S. rice varieties to sheath blight is listed in Table 17. Most of the common rice varieties grown in the south are moderately to highly susceptible to sheath blight. Although there is not a high level of tolerance to sheath blight available, growers reported using sheath blight/blast tolerant varieties, as an alternative to chemical control, on approximately 6 percent of the total acreage in Arkansas, Louisiana, and Texas (California varieties are not selected for sheath blight resistance) (Table 18). The estimates provided by growers are probably low. By comparing the rice varieties planted (Table 3) with the disease resistance rating (Table 17) it can be seen that the varieties with the highest levels of sheath blight tolerance (Katy and Mars) were planted on approximately 13 percent of the total acreage for Arkansas, Louisiana, and Texas.

Even with some sheath blight tolerance available, cultural practices and fungicides are important in managing the disease. Table 18 lists the responses that rice growers gave when questioned about their use of non-chemical alternatives to fungicides (i.e., cultural practices, resistant varieties, etc.) for disease control. In Arkansas, Louisiana, and Texas, rice growers indicated they used the following cultural practices to help control sheath blight: water management, reduced plant density, and fertilization management. When questioned about the quality of sheath blight control provided by these cultural practices the growers indicated the control was fair to poor (the targeted pests and the quality of control for each pest control practice are contained in the individual state results in Appendix B). Resistant/tolerant varieties were rated by the growers as the non-chemical approach providing the highest level of sheath blight control.

Although sheath blight is the most prevalent rice disease, blast can be the most damaging rice disease in a given year. Annual yield loss estimates for blast range from 10-20%, but losses as high as 60-90% have been recorded during rice blast epidemics in the south since 1986 (11).

Blast is caused by a fungus that produces microscopic spores that are easily wind-borne and can be transported for many miles. The blast spores come primarily from rice stubble. Several races of the fungus exist and individual varieties

Table 17. Reaction of Southern U.S. Rice Varieties to Diseases*.

Variety	Sheath Blight	Straighthead	Stem Rot	Kernel Smut	Brown Spot	Rice Blast Races			
						IG1	IH1	IC17	IB49
Lemont	8**	4	—	3	4	1	1	6	5
Gulfmont	8	4	—	—	3	1	1	5	6
Katy	5	5	—	—	3	1	1	1	2
Newbonnet	6	4	7	6	4	1	1	8	8
Alan	6	5	—	6	5	4	5	7	8
Maybelle	7	3	—	5	4	7	7	7	8
Mars	5	7	6	1	7	2	2	3	8
Millie	6	7	—	4	3	7	7	7	7
Jackson	7	4	—	—	4	7	4	5	7

* From Cooperative Regional Uniform Rice Nursery, Don Groth (Louisiana State University) and M.A. Marchetti (USDA-ARS), Cooperating.

** Summary of degree of susceptibility: 1 = least susceptible to 9 = most susceptible; — indicates data insufficient for rating. Ratings are not data but indications of potential damage under conditions favorable for development of specific diseases.

Table 18. Acres Treated for Each Alternative Disease Control Practice (Grower Survey).

Alternative Disease Control Method	Total Acres Treated by State, ( )= % of Acres Treated by State				Total Acres Treated, ( )= % of Total Acres Treated (AR,LA,CA,TX)
	AR	CA	LA	TX	
Resistant varieties	70,400 (5.5)	16,280 (3.7)	50,685 (9.3)	12,600 (4.2)	149,965 (5.8)
Water management	35,840 (2.8)	2,640 (0.6)	—	6,300 (2.1)	44,780 (1.7)
Reduced plant density	26,880 (2.1)	—	—	15,900 (5.3)	42,780 (1.7)
Fertilization management	3,840 (0.3)	—	—	5,100 (1.7)	8,940 (0.3)
Cultural practices (not named)	—	13,200 (3.0)	21,255 (3.9)	3,000 (1.0)	37,455 (1.5)
Burning of rice straw	—	16,720 (3.8)	—	—	16,720 (0.7)
Crop rotation	—	6,600 (1.5)	—	—	6,600 (0.3)
Straw incorporation	—	2,200 (0.5)	—	—	2,200 (0.1)

react differently to a specific blast race. The blast pathogen is very dynamic and highly virulent races often develop on resistant varieties. Most of the recommended varieties are highly resistant to races IH-1 and IG-1 which were predominant prior to 1985. Previously uncommon races IC-17 and IB-49 increased rapidly beginning in 1986 and were found over a wide area in the southern rice growing regions by 1987 (12). Almost all of the rice varieties (except for Katy and to some extent Mars) listed by rice growers are moderately to highly susceptible to the IC-17 and IB-49 races of the pathogen (Table 17).

Blast symptoms first appear as diamond or spindle shaped spots on the leaves. The "rotten neck" phase occurs when the collars, nodes, or stems of panicles become infected. Once infected, these damaged tissues prevent the grain from filling or they weaken the neck of the panicle so that filled heads break off before harvest.

Spread of blast can be rapid from a single infected plant within the field or to neighboring fields. The pattern of infection is generally in the direction of the prevailing wind. Obstructions such as tree lines can interfere with air currents as well as provide early morning shade across small fields that delay the evaporation of dew favoring disease development.

Choosing, when possible, the least susceptible rice variety is one way of managing blast, but additional measures are often needed. These include: avoiding thick stands; avoiding excessive nitrogen fertilization; flushing the field and using gibberellic acid seed treatments to promote uniform rice emergence; choosing open, less sandy fields free of tree lines; scouting fields for early blast symptoms; and applying the recommended fungicide, benomyl, when disease development is progressing in the field, especially on highly susceptible varieties (12).

The surveyed growers indicated they used the following non-chemical approaches to help control blast: resistant varieties; water management; thinner stand; and unspecified cultural practices (Table 18). The growers estimated the quality of control provided by these practices ranged from excellent to poor (the targeted pests and the quality of control for each pest control practice are contained in the individual state results in Appendix B). Resistant varieties were rated by the growers as the non-chemical approach providing the highest level of blast control.

An important component of managing both sheath blight and blast is the use of fungicides. Table 19 shows the results of the grower surveys concerning fungicide use on rice. Benomyl, propiconazole, and iprodione were used on approximately 24%, 10%, and 6%, respectively, of the total rice acres for Arkansas, Louisiana, and Texas (fungicides were not used in California). The total pounds of active ingredient applied for benomyl, propiconazole, and iprodione were 273,281, 54,314, and 65,810 pounds respectively. A total of 393,405 pounds of fungicide active ingredient was applied in these three states.

Benomyl is the only one of these three fungicides that has significant activity against both sheath blight and blast. Propiconazole and iprodione are not effective in controlling blast. Propiconazole is roughly equal to benomyl in controlling sheath blight and some of the other fungal diseases. Iprodione is slightly less effective than propiconazole on these diseases. The fact that benomyl has activity on the two major rice diseases is indicative of why it is used on significantly more acres than the other two fungicides. In addition, if blast is the primary targeted disease, benomyl is the <u>only</u> fungicide that will provide control (11). A copy of this reference, entitled "Benomyl Benefits Assessment on Rice in the Southern United States," is included as Appendix E.

Most of the other major diseases listed by growers and specialists (Tables 15 and 16) can be controlled by using the three fungicides listed above (alone or in sequential combinations) along with various cultural controls. Exceptions are straighthead control in the southern states and stem rot (*Sclerotium oryzae*) and sheath spot (*Rhizoctonia oryzae-sativae*) control in California.

Straighthead is a physiological disorder of rice thought to be related to arsenic levels in sandy silt loam soils. It may also occur in soils high in organic matter. Affected plants may fail to produce normal grain and under severe situations the panicles fail to emerge from the boot resulting in no yield from the affected plant. Control for straighthead can be obtained by thoroughly drying the soil just before the rice reaches the reproductive stage (internode elongation) then reflooding by 1/2 inch internode elongation (12).

Stem rot is the primary disease of concern to California rice growers and it is becoming a problem in Arkansas (5). Twenty-five percent of the California growers listed stem rot as the

disease causing the greatest monetary loss on their rice crop. The problem is exacerbated because there are no fungicides registered for use on California rice and the rice cultivars grown in California are all susceptible, in varying degrees, to stem rot. The most important aspect of stem rot control is limiting the number of overwintering sclerotia. Burning or removing infected rice residues are the two best methods for reducing the sclerotium levels (9).

Previously in California the most common method to reduce stem rot was to burn the rice stubble after harvest. While burning is a good control method for stem rot, it can lead to air quality problems and is therefore being phased out in California. Research has shown that cutting the rice straw at or near ground level and then removing the residue from the field is nearly as effective as burning for managing stem rot (7). The major drawback to total removal of residues is the difficulty in baling or collecting the straw and the expense of disposing of it since there are no commercial markets for this by-product . In some cases the straw residue can be incorporated into the soil to reduce the inoculum levels of stem rot. In order to reduce the levels of the pathogen the rice straw must be buried as deeply as possible. This necessitates the use of moldboard plowing or other means of deep incorporation (9).

Rice disease specialists were surveyed to determine the potential impact of losing certain fungicides for use on rice. The specialists were asked to list the alternatives that would be used if a particular fungicide was "lost" for use on rice. The specialists also estimated the yield impact if the alternatives for the fungicide were used or not used. In addition, the specialists were asked to estimate the impact of losing all fungicides. The results are in Tables 20 and 22. The individual state's specialist surveys are contained in Appendix D.

The specialists indicated that the alternatives for any "lost" fungicide were the other two rice fungicides and resistant/tolerant varieties. The largest negative yield impact due to losing a fungicide, whether using or not using the available alternatives, was for benomyl. This is significant in that benomyl use on rice has been listed as a use that may be affected by the strict interpretation of the "Delaney Clause" in Section 409 of the Federal Food, Drug and Cosmetic Act (FFDCA). Under EPA's coordination policy the registration of benomyl on rice could be revoked because of residue problems on rice hulls. (However, at the time of this writing, EPA is proposing to eliminate the Section 409 tolerance for benomyl as unnecessary so that the Delaney Clause would not affect benomyl use on rice.) Rice specialists have indicated rice yields could drop 15-50% due to blast if registration of benomyl on rice is lost. Specialists comments on the affects of losing benomyl, as well as the other fungicides, are contained in Table 21. In general, they responded that there is no consistent, viable alternative to benomyl for controlling blast.

The specialists indicated that losing propiconazole or iprodione would not cause large negative yield impacts as long as alternatives were available. In fact, certain specialists responded that using alternatives for iprodione (i.e., benomyl and propiconazole) could actually increase yields by 2-3% because the alternatives are slightly more effective on the primary fungal diseases.

The impact of losing all rice fungicides was also addressed by the rice specialists (Tables 22 and 23). The specialists indicated that if all rice fungicides were "lost" yields would decline from 10-50% even if the available alternatives to fungicides were used.

The economic impacts of losing certain fungicides used on rice are discussed in more detail in the economic assessment section of this report.

Table 19. Acres Treated for Each Fungicide, Average Rate (Pounds of Active Ingredient) Per Acre, and Total Pounds of Active Ingredient (Grower Survey).

Fungicide	Total Acres Treated by State ( ) = % of Acres Treated AR	LA	TX	Total Acres Treated ( ) = % of Total Rice Acres (AR,LA,TX)	Avg. Rate (lbs ai) Per Acre	Total Pounds Active Ingredient
benomyl	331,800 (25.9)	122,625 (22.5)	61,200 (20.4)	515,625 (24.3)	0.53	273,281
propiconazole	141,400 (11.0)	32,700 (6.0)	34,800 (11.6)	208,900 (9.8)	0.26	54,314
iprodione	77,000 (6.0)	14,170 (2.6)	33,000 (11.0)	124,170 (5.8)	0.53	65,810

Table 20. Individual Fungicides, Acreage Treated, Fungicide Use in Pounds of Active Ingredient, Alternative Treatments and Impact on Rice Yield With and Without Availability of Alternatives. Note: No fungicides are registered for use in California.

Fungicide	% of Total Rice Acres Treated (AR,LA,TX)	Rice Acres Treated (AR,LA,TX)	Fungicide Use (pounds ai)	Alternatives, ( ) = No. of States Listing Alternative (Specialist/Researcher Survey)	Yield Impact*	
					W/Alt.	W/O Alt.
benomyl	24.3	515,625	273,281	Iprodione(3), Propiconazole(3), Resistant varieties(1)	(+)5% to (-)30%	(-)15% to (-)50%
propiconazole	9.8	208,900	54,314	Benomyl(3), Iprodione(3), Tolerant varieties(1)	0 to (-)2%	(-)10% to (-)25%
iprodione	5.8	124,170	65,810	Benomyl(3), Propiconazole(3), Tolerant varieties(1)	(+)2-3%	(-)8% to (-)25%

*Numbers listed are the range of estimates provided by the responding specialists.

Table 21. Secondary Effects Due to the Use of Alternatives for Specific Fungicides as Reported by Specialists/Researchers.

Fungicide	Secondary Effects Due to Use of Alternatives*, ( ) = Number of States Listing the Effect
benomyl	Using resistant varieties to control blast could lead to greater selection pressure for blast races to overwhelm variety resistance (1). Greater risk to the very damaging and potentially explosive blast disease which is only controlled by benomyl (1). 3. No alternative control of blast but cultural/management practices which are inconsistent (1). The following are additional comments from the rice specialists concerning alternatives to benomyl: Benomyl has a characteristic that is to hard properly evaluate in surveys such as this one. It is the only product that is effective against blast, a very damaging disease, but very erratic in its year-to-year occurrence and damage. When blast is active during some years, benomyl's importance to the rice industry increases tremendously (Texas). The assumption with alternative fungicides (or alternatives in general) is that the disease trying to be managed is sheath blight. If blast is the one in question, there is no alternative to benomyl. The other products have no activity against *Pyricularia grisea* (Louisiana). Resistant variety options are very limited for the major diseases. Alternative fungicides currently are not available to replace benomyl for blast control. Rough rice yields would be reduced by loss of control options. The quality of harvested grain would also be reduced (Arkansas).
iprodione	Increased costs (1).
propiconazole	Increased costs (1).

*Comments provided by specialists are listed verbatim.

Table 22. Rice Fungicide Groups, Acreage Treated, Fungicide Use in Pounds of Active Ingredient, Alternative Treatments and Impact on Rice Yield With and Without Availability of Alternatives. Note: No fungicides are registered for use in California.

Fungicide Group	% of Total Rice Acres Treated (AR,LA,TX)	Rice Acres Treated (AR,LA,TX)	Fungicide Use (pounds ai)	Alternatives, ( ) = No. of States Listing Alternative (Specialist/Researcher Survey)	Yield Impact*	
					W/Alt.	W/O Alt.
ALL FUNGICIDES	33.0	848,695	393,405	Resistant varieties(2), Tolerant varieties(2), Planting date(2), Fertility levels(2), Seeding rate(2), No adequate alternatives(1)	(-)10% to (-)40%	(-)10% to (-)50%

*Numbers listed are the range of estimates provided by the responding specialists.

Table 23. Secondary Effects Due to the Loss of All Rice Fungicides as Reported by Specialists/Researchers

Fungicide Group	Secondary Effects Due to Use of Alternatives*, ( ) = Number of States Listing the Effect
ALL FUNGICIDES	Disease control would be reduced with yield and quality losses (2). Development of new "races" of *P. oryzae* to resistance in Katy (variety) rice (1). Alternative options are very limited and in some cases not efficacious. Resistant variety options are very limited. Total rough rice yields will be reduced. Quality of the harvested grain will be reduced. Grain will be lightweight with reduced milling yields (1). There are some cultural alternatives which I chose not to list because a single table does not adequately reflect their impact. Such practices are early planting, nitrogen management, proper seeding rate, skip-row planting, "resistant" varieties for blast and "tolerant" varieties for blast, etc. None, or all, of these are often not adequate and fungicides are a must. I do not know of an adequate and acceptable way to list all these cultural practices in the Table provided and their impact on yields. So I have listed "no adequate alternatives" as the more appropriate response. Also many of these practices are not always "alternatives" but "complementary" practices (1).

*Comments provided by specialists are listed verbatim.

INSECT CONTROL

The aquatic environment of a rice field discourages many potential invertebrate pests, but there are a number of economically important insects that routinely infest rice and can cause significant damage to the crop. Most of these are aquatic organisms or have a stage in their life cycle which requires an aquatic environment (i.e., rice water weevil [*Lissorhoptrus oryzophilus*], rice seed midge [*family: Chironomidae*], tadpole shrimp [*Triops longicaudatus*], crayfish [*Procambarus clarki* and *Orconectes virilis*], rice leaf miner [*Hydrellia griseola*]). Other insect pests of rice (i.e., grasshopper [*family: Acrididae*] and rice stink bug [*Oebalus pugnax*]) avoid the water by flying to the rice crop. Some terrestrial insect pests (i.e., chinch bug [*Blissus leucopterus leucopterus*] and armyworm [*Pseudaletia unipuncta* or *Spodoptera frugiperda*]) damage rice early in the growing season before the permanent flood is established.

Tables 24 and 25 show the results when rice growers and rice specialists were asked to list the insects causing the greatest monetary loss in rice. The growers were asked to list the insect(s) causing the greatest monetary loss in 1993 (1992 for Arkansas) while the specialists were asked to rank the insects for an average year. This may explain why there are differences in the overall ranking of a given insect.

Although the rankings are somewhat different, the four insects listed as causing the greatest monetary loss (i.e., rice water weevil, rice stink bug, grasshopper, and armyworm), were listed by both growers and specialists. It should be noted that in the south, fall armyworm (*S. frugiperda*) replaces armyworm (*P. unipuncta*) as a serious pest. Of these four, the rice water weevil and rice stink bug are the most significant rice insect pests (see Overall Percentage and Overall Ranking columns in Tables 24 and 25).

Stink bug damage results in a loss of quantity and quality. Stink bug feeding on the immature grain can completely remove the grain's contents thereby reducing yield. In addition, when stink bugs pierce the surface of the grain the resulting hole can serve as a pathway for other organisms to infect the grain. The affected grains can shrivel or become discolored. The presence of discolored grain, commonly called "pecky or peck" rice lowers the grade and therefore the market value of the rice.

Methyl parathion, carbaryl, and malathion are all used to control stink bug infestations. Scouting for stink bug levels in the rice field is recommended by most states. Economic thresholds for stink bugs, developed by rice researchers and specialists, help growers to determine the need for an insecticide application to control the pest.

Another consideration when using these three pesticides for early season pests, such as chinch bugs and armyworms, is their interaction with propanil. Rice injury results if these insecticides are applied within a certain number of days of a propanil application. The label states that malathion should not be applied within 14 days of a propanil application, methyl parathion within 7 days and carbaryl within 15 days.

Rice growers in Arkansas, Louisiana, and Texas (stink bugs are not a significant problem in California rice) responded that of all the insecticide applications made, with the exception of carbofuran, the majority were targeted at controlling stink bugs (see individual states results in Appendix B).

Table 26 indicates that rice growers in Arkansas, Louisiana, and Texas used approximately 221,000 pounds of active ingredient of methyl parathion, malathion, and carbaryl on approximately 428,000 acres in 1993 (1992 for Arkansas). California rice growers used approximately 22,000 pounds of active ingredient of methyl parathion on 47,520 acres, but these applications were targeted primarily at tadpole shrimp and rice seed midge (see individual state report in Appendix B.).

No non-chemical alternatives to insecticides for control of stink bug were listed by the growers in the three states (see individual state reports in Appendix B). The surveyed rice specialists indicated that the alternatives to any one of these three insecticides were the other two pesticides (i.e., there are no effective non-chemical controls for stink bug). However, variety selection can influence rice stink bug infestations. Early season varieties, such as "Alan," "Jackson," "Maybelle," etc., are often planted first and begin to head first. Stink bugs infest the early heading varieties and cause damage. When short and mid-season varieties begin to head, stink bugs are dispersed over a greater area and damage to these varieties is less. In addition, some varieties are more susceptible to rice stink bug than others. "Katy," "Kaybonnet," and "LaGrue" are much less susceptible than "Newbonnet" and "Lemont" (2).

Table 24. Grower Ranking of Insects/Arthropods Causing the Greatest Monetary Loss to the 1993 (1992 for AR) Rice Crop. Numbers represent the percentage of growers listing the insect.

Insect/Arthropod	% of Growers Listing Each Insect/Arthropod, by State				Overall Percentage*	Overall Ranking**
	AR	CA	LA	TX		
Oebalus pugnax (Rice Stink Bug)	22	—	30	57	27.5	1
Lissorhoptrus oryzophilus (Rice Water Weevil)	6	30	41	9	15.7	2
Family: Acrididae (Grasshopper)	8	—	5	5	5.2	3
Pseudaletia unipuncta (Armyworm) or *Spodoptera frugiperda* (Fall Armyworm)***	4	—	—	7	3.2	4
Triops longicaudatus (Tadpole Shrimp)	—	16	—	—	2.8	5
Blissus leucopterus leucopterus (Chinch Bug)	1	—	—	3	0.9	6
Chilo plejadellus (Rice Stalk Borer) or *Diatraea saccharalis* (Sugarcane Borer)	1	—	—	1	0.9	6
Procambarus clarki and Orconectes virilis (Crayfish)	—	1	—	—	0.2	7
Family: Chironomidae (Rice Seed Midges)	—	—	—	1	0.2	7

* The overall percentage is based on the total number of growers listing an insect as compared to the total number of growers responding to the question.

** The insect/arthropod listed as causing the greatest monetary loss in the 1993 (1992 for AR) rice crop is ranked number 1, the next most economically damaging insect/arthropod is ranked number 2, etc.

*** *Spodoptera frugiperda* (Fall Armyworm) is a sporodic problem in the south, while *Pseudaletia unipuncta* (Armyworm) is a problem in California.

Table 25. Specialist Ranking of Insects/Arthropods Causing the Greatest Monetary Loss to the Annual Rice Crop. Numbers represent the average ranking of a insect by the various rice insect specialists in the given state.

Insect/Arthropod	Insect/Arthropod as Ranked by the State's Rice Specialists*				Overall Ranking**
	AR	CA	LA	TX	
Lissorhoptrus oryzophilus (Rice Water Weevil)	2	1	1	1	1
Oebalus pugnax (Rice Stink Bug)	1	—	2	1	2
Pseudaletia unipuncta (Armyworm) or *Spodoptera frugiperda* (Fall Armyworm)	4	6	3	2	3
Family: Acrididae (Grasshopper)	3	—	6	3	4
Blissus leucopterus leucopterus (Chinch Bug)	5	—	5	3	5
Chilo plejadellus (Rice Stalk Borer) or *Diatraea saccharalis* (Sugarcane Borer)	6	—	—	4	6
Family: Chironomidae (Rice Seed Midges)	—	4	—	4	7
Triops longicaudatus (Tadpole Shrimp)	—	2	—	—	8
Procambarus clarki and Orconectes virilis (Crayfish)	—	3	—	—	9
Hydrellia griseola (Rice Leaf Miner)	—	5	4	—	10

* The insect/arthropod listed as causing the greatest monetary loss for an average year is ranked number 1, the next most economically damaging insect/arthropod is ranked number 2, etc.

** Overall rankings were achieved by: 1) multiplying a state's acreage in rice production by 10 for a pest ranking of 1 within that state, 9 for 2,..., and 1 for 10 or more and 2) adding the resulting numbers by pest from all reporting states together, and then 3) taking the resulting pest scores and numerically ranking the highest pest score as number 1, the second highest as 2, etc.

Although differences in susceptibility exist, there are no rice varieties that are not damaged by rice stink bug. Growers can choose a variety that has less susceptibility than others. Information about susceptibility of rice varieties to rice stink bug is available through Extension Service publications from the various states.

The rice water weevil is a significant rice pest in most growing areas not only because of damage to the rice plant but also because the control strategies are very limited. Only one insecticide formulation, granular carbofuran, is labeled for rice water weevil control in rice. The registration for carbofuran on rice is scheduled for cancellation after the 1997 growing season due to perceived bird mortality problems. There are non-chemical approaches for controlling rice water weevil, but the level of control is not satisfactory in most cases.

The adult rice water weevil feeds primarily on rice leaves causing little economic damage. After moving into rice fields in the spring the adult females deposit eggs in the rice leaf sheaths below the water line. After larvae emerge from eggs they move to the roots and begin feeding. Root feeding by the larvae results in yield loss by reducing growth, tillering, and plant vigor. Water seeded rice favors the development of the rice water weevil because of the duration of flooded conditions. Drill seeding can help reduce numbers or densities of the insect.

Chemical control of rice water weevil centers around the use of carbofuran. Growers in all four surveyed states reported using 173,715 total pounds of the active ingredient carbofuran on 347,430 acres of rice (13.5% of total) (Table 26). California and Louisiana reported the highest use of carbofuran. These two states also have the highest percentage of water seeded acres (Table 2). The individual state reports (see Appendix B) indicate that virtually all carbofuran applications were targeted at the rice water weevil. The majority of growers rated the quality of control as good to excellent.

The rice specialists from the various states were questioned concerning the impacts of losing carbofuran, as well as other insecticides, for use on rice. Their responses are contained in Tables 28 and 29. The specialists indicated there are currently no chemical alternatives for carbofuran in controlling rice water weevil. Water management, controlling levee vegetation, planting date, crop rotation, and drill seeding or dry broadcast seeding were the non-chemical alternatives listed by the specialists and rice growers (see individual state's results in Appendix B).

Water management for controlling rice water weevil involves a method known as "drain and dry" which can be used in drill seeded fields. With this method the rice field is drained approximately ten days after the permanent flood is established. The soil is allowed to dry until cracks appear and then reflooded. Drying the soil reduces the number of rice water weevil larvae. Limitations in controlling rice water weevil with this method include: pumping costs for reflooding, risk of nitrogen loss, weed reinfestation, increased mosquito problems, and the possibility of wet weather interfering with drying the field. Also, delaying the permanent flood relative to rice emergence can reduce rice water weevil populations and damage, but this method can also lead to more fertilizer and herbicide use, delay in rice maturity, and higher water useage.

It should be noted that water management is necessary with postplant applications of carbofuran in water seeded rice. The field is drained (soon after the rice emerges from the water), the carbofuran is applied, and the field is immediately reflooded. This method has essentially the same limitations as the "drain and dry" method. Preventative applications of carbofuran in fields with a history of rice water weevil problems are applied as preplant incorporated treatments.

Controlling the vegetation on the levees and field borders can help eliminate overwintering sites of the rice water weevil although this method has not proven to be very effective. It has been reported that early planted or late planted rice is likely to escape heavy infestations of the insect by avoiding peak emergence times of the rice water weevil adults (12).

Drill seeding and dry broadcast seeding, and the associated drier conditions early in the life cycle of the rice plant, apparently inhibit adult egg laying until the permanent flood is applied. This results in larger plants at the time of the perma-

nent flood. These larger plants are less preferred oviposition hosts and tolerate rice water weevil damage better than smaller plants (personal communication, M. O. Way).

The majority of growers indicated the quality of rice water weevil control provided by the "drain and dry" method for drill seeded rice was good to excellent (individual state results are in Appendix B). The estimated quality of control of the other non-chemical approaches was from fair to good.

The only other non-chemical alternative listed by growers for controlling rice insects was *Bacillus thuringiensis* (various trade names). One Texas rice grower reported using *B. thuringiensis* to control armyworms. The grower reported the control provided by the product was poor. Texas growers commonly control fall armyworms and/or chinch bugs by flushing fields or applying an early permanent flood. Rice seed midges can be controlled by timely draining of fields (personal communication, M. O. Way).

The rice specialists indicated that using non-chemical alternatives for rice water weevil without the availability of carbofuran could reduce yields by 5-20% (Table 28). The specialists comments concerning carbofuran and other insecticides are listed in Table 29. In general, the rice specialists responded that there are no chemical alternatives for carbofuran and that non-chemical means of control are inadequate.

An excellent review of carbofuran use on rice entitled: "The Biologic and Economic Assessment of Carbofuran - A report of the Carbofuran Assessment Team to the Special Review of Carbofuran, is included as Appendix F. The report was submitted to the U.S. Environmental Protection Agency on December 22, 1989 by U.S. Department of Agriculture in cooperation with State Agricultural Experiment Stations, Cooperative Extension Service, Other State Agencies, and EPA.

The rice specialists were also asked to assess the impact(s) of losing groups of rice insecticides. Their responses are listed in Tables 30 and 31. The specialists estimated that losing either organophosphate or carbamate insecticides would result in yield reductions of zero to 25% if the alternatives to these two groups were available. If the alternatives are not available the specialists estimated the yield loss would be in the range of 5 to 40 percent. If all rice insecticides were "lost" the specialists estimated that the yield reduction would be 6-30 percent using the available alternatives and 15-35 percent without the available alternatives. The secondary effects of losing the insecticide groups, as listed by the specialists, are given in Table 31.

The economic impacts of losing certain insecticides used on rice will be discussed in more detail in the economic assessment section of this report.

Table 26. Acres Treated for Each Insecticide, Average Rate (Pounds of Active Ingredient) Per Acre, and Total Pounds of Active Ingredient (Grower Survey).

Insecticide	Total Acres Treated by State ( )= % of Acres Treated				Total Acres Treated ( )= % of Total Acres Treated (AR,LA,CA,TX)	Avg. Rate (lbs ai) Per Acre	Total Pounds Active Ingredient
	AR	CA	LA	TX			
methyl parathion	77,000 (6.0)	47,520 (10.8)	93,470 (17.2)	173,100 (57.7)	391,090 (15.2)	0.47	183,812
carbofuran	12,600 (1.0)	151,800 (34.5)	160,230 (29.4)	22,800 (7.6)	347,430 (13.5)	0.50	173,715
copper sulfate	—	126,270 (28.8)	—	4,800 (1.6)	131,520 (5.1)	10.9	1,433,568
malathion	49,000 (3.8)	—	—	2,100 (0.7)	51,100 (2.0)	0.56	28,616
carbaryl	4,200 (0.3)	—	—	28,800 (9.6)	33,000 (1.3)	0.93	30,690
cyhalothrin	—	—	—	3,600 (0.1)	3,600 (0.1)	0.023	83

Table 27. Acres Treated for Each Alternative Insect Control Practice by State and Total Acres Treated (Grower Survey)

Alternative Insect Control Method	Total Acres Treated by State, ( )= % of Acres Treated				Acres Treated ( )= % of Total Acres Treated (AR,LA,CA,TX)
	AR	CA	LA	TX	
Water management (drying field)	34,560 (2.7)	12,320 (2.8)	21,255 (3.9)	11,100 (3.7)	79,235 (3.1)
Cultural practices (not specified)	—	25,080 (5.7)	—	3,000 (1.0)	28,080 (1.1)
Clean field borders/levees	—	9,680 (2.2)	—	—	9,680 (0.4)
Crop rotation	—	6,600 (1.5)	—	—	6,600 (0.3)
Bicillus thuringiensis	—	—	—	600 (0.2)	600 (0.02)

Table 28. Individual Insecticides, Acreage Treated, Insecticide Use in Pounds of Active Ingredient, Alternative Treatments and Impact on Rice Yield With and Without Availability of Alternatives.

Insecticide	% of Total Rice Acres Treated (AR,LA,CA,TX)	Rice Acres Treated (AR,LA,CA,TX)	Insecticide Use (pounds ai)	Alternatives, ( ) = No. of States Listing Each Alternative (Specialist/Researcher Survey)	Yield Impact*	
					W/Alt.	W/O Alt.
methyl parathion	15.2	391,090	183,812	malathion(4), carbaryl(2)	0 to (-)10%	0 to (-)30%
carbofuran	13.5	347,430	173,715	No reliable alternatives, chemical or non-chemical(4), Water management(2), Clean levee vegetation(1), Delay planting date(1), Drill seeding(1)	(-)5% to (-)20%	(-)5% to (-)40%
malathion	2.0	51,100	28,616	carbaryl(2), methyl parathion(2)	0 to (-)10%	(-)4% to (-)30%
carbaryl	1.3	33,000	30,690	malathion(4), methyl parathion(2), copper sulfate(1)	0 to (-)5%	(-)1% to (-)30%

*Numbers listed are the range of estimates provided by the responding specialists.

Table 29. Secondary Effects Due to the Use of Alternatives for Specific Insecticides as Reported by Specialists/Researchers.

Insecticide	Secondary Effects Due to Use of Alternatives*, ( )= Number of States Listing the Effect
carbofuran	Increased weed control, fertilizer, and water costs, due to draining field or delaying flood for rice water weevil control (4). Destruction of avian/wildlife habitat due to levee vegetation management (reduces overwintering sites of the insect) (1). No chemical alternatives at this time although one or two chemicals being evaluated have the efficacy. Cost of the new chemicals may be the same or greater than carbofuran. Cultural practices such as drain and dry, delayed flood, and drill-seeded rice can be effective. Associated problems with drain and dry have been discussed. Yield losses could range from 5% to less than 40% if carbofuran was lost and no chemical replacement was available (1).
methyl parathion	Increased costs (1). Some propanil/insecticide interaction damage to plants (1). Carbaryl (as an alternative) not as effective as methyl parathion in controlling rice stink bug. Rice stink bug does not affect yield; only quality. If methyl parathion were lost, carbaryl would replace it with no change in yield or quality but an increase in production costs because carbaryl is more expensive than methyl parathion, however, if both carbaryl and methyl parathion were lost, then quality would be significantly affected! (1). Carbaryl and malathion could be used with minimal changes in yield (0-3%) if the chemicals were properly timed (1).
malathion	Some propanil/insecticide interaction damage to plants (1). Methyl parathion and carbaryl could replace malathion with minimal changes in yield (0-3%) if the chemicals were properly timed (1).
carbaryl	Carbaryl is slightly better than methyl parathion for control of rice stink bug in that it has a longer residual time on the rice. Loss of carbaryl would not significantly decrease yields or quality of rice. Methyl parathion is the choice of most growers because it is cheaper, but has a much shorter residual time. Minimal changes in yield (0-3%) if chemicals are properly times (1). See comments for methyl parathion.

*Comments provided by specialists/researchers are listed verbatim.

Table 30. Rice Insecticide Groups, Acreage Treated, Insecticide Use in Pounds of Active Ingredient, Alternative Treatments and Impact on Rice Yield With and Without Availability of Alternatives.

Insecticide Group	% of Total Rice Acres Treated (AR,LA,CA,TX)	Rice Acres Treated (AR,LA,CA,TX)	Insecticide Use (pounds ai)	Alternatives, ( ) = No. of States Listing Each Alternative (Specialist\Researcher Survey)	Yield Impact*	
					W/Alt.	W/O Alt.
Organophosphates	17.2	442,190	212,428	Carbamates(2), Lower water depth during cool weather for rice leafminer control(1)	0 to (-)25%	(-)5% to (-)30%
Carbamates	14.8	380,430	204,405	Organophosphates(2), Drainage for rice water weevil(2), No reliable chemical alternatives to carbofuran(3), Clean levee vegetation(1), Delay planting date(1), Drill seeding(1)	(-)3% to (-)20%	(-)5% to (-)40%
ALL INSECTICIDES	32.1	826,220	416,812	Drain field for rice water weevil control(2), Delaying flood for rice water weevil control(1), Applying flushes(1), Cultural practices(1)	(-)6% to (-)30%	(-)15% to (-)35%

*Numbers listed are the range of estimates provided by the responding specialists.

Table 31. Secondary Effects Due to the Use of Alternatives for Specific Insecticide Groups as Reported by Specialists/Researchers.

Insecticide Group	Secondary Effects Due to Use of Alternatives,* ( )= Number of States Listing the Effect
Organophosphates	Propanil/insecticide damage would be severe (1). Organophosphates are generally cheaper; malathion is used in crawfish ponds double cropped with rice; carbaryl cannot be used (1). Rice stink bug does not reduce yield - reduces quality. Loss of methyl parathion would have major impact because of increase cost of control when carbaryl is used. Brorsen, Grant and Rister (1984) (see Reference section No. 4) found that a 1% point decrease in peck (blemished or otherwise damaged) was worth about $20 to $60 per acre. If we assume that insecticide applications, in general, lower peck one percentage point then Texas farmers would lose between $3 million and $9.75 million (minus control costs) annually given withdrawal of insecticides on 150,000 acres (assume about 1/2 of Texas acreage is treated for rice stink bug) (1). Carbaryl would become the only chemical available. Interaction with propanil for control of early season pests would become more acute (1).
Carbamates	(Drainage for rice water weevil is) not a reliable means of control; increased herbicide usage; increased water cost (2). For some pests the organophosphates could replace the carbamates with little change to yield if the chemicals were used often enough and timed properly. With no replacement for carbofuran, yield losses could range from 5% to less than 40% (1).
ALL INSECTICIDES	All the cultural controls have significant drawbacks, as shown in the previous Table. (Host plant resistance) is being worked on but yield potential is still low, poorer grain quality. Nothing (in the form of biological controls) is available at this time. Biocontrols need further research but the research to date has shown no "silver bullets" (1). (The estimated yield reduction of at least 15% if all rice insecticides were lost is indicative of) value of quality reduction due to failure to control rice stink bug. (There is) no alternative for control of rice stink bug if we lose all insecticides (1). Relying on cultural practices would be unacceptable to growers because of considerable losses to yield and quality. More research emphasis would need to be placed on insect resistant varieties or other changes in cultural practices, such as planting dates, variety selection, etc. Yield and quality losses could be from 5% to 40%.

*Comments provided by specialists/researchers are listed verbatim.

ECONOMIC ASSESSMENT OF PESTICIDE USE ON RICE – METHODOLOGY

The Arkansas Rice Model was used to evaluate the economic impact on the rice industry as a result of banning selected rice pesticides (16). Proposed changes in pesticide use were compared with the international rice baseline projections for 1995. Projections include national levels of production, utilization, net trade, stocks, and prices for the United States and 15 other major rice producing and/or trading countries. The United States is also broken down into the individual states of Arkansas, California, Louisiana, Mississippi, Missouri and Texas. However, Missouri was not included in the survey.

The banning of three major rice pesticides – 2,4-D, carbofuran, and benomyl – was evaluated. These pesticides were selected because of the possibility that their registration on rice due to adverse human and wildlife affects could be cancelled. The percent of rice acres treated with each of these pesticides and the estimated yield impact, both with alternatives and without, is presented in Table 32. This information is a compilation of survey results completed by rice specialist in each state. The percentage of acres treated was multiplied by the yield impact to estimate the change in total U.S. production. The Arkansas Rice Model was then used to determine the economic impact on the U.S. rice industry as a result of these six proposed scenarios. The scenarios were calculated assuming the pesticides were banned beginning in 1996 and are projected through the year 2005. The current farm program was assumed to remain constant throughout the planning period.

RESULTS AND DISCUSSION

The output variables used to analyze the six scenarios presented in Table 32 were U.S. rice production, farm price, retail price and net returns per acre above variable costs. Tables 33 through 36 present the Arkansas Rice Model baseline projections of the output variables for 1996 through 2005. Also presented are six scenarios estimating the impact on U.S. rice production after separately banning 2,4-D, carbofuran, and benomyl, with alternatives available and if alternatives were not available. Also presented for each scenario is the percent change from the baseline. This information is presented graphically in the appendix.

ECONOMIC IMPACT RESULTING FROM A BAN ON 2,4-D

The projected change in production resulting from banning 2,4-D with alternatives available is minimal (Table 33). Production decreases less than 1% throughout the 1996-2005 period. However, banning 2,4-D without alternatives available results in a decrease in production ranging from 6.69% to 8.25%.

U.S. farm price is affected most in the first two years after banning 2,4-D when alternatives are available (Table 34). The farm price increases a modest .82% and .68% in 1996 and 1997, respectively. The impact is even less in the remaining

Table 32. Percent of U.S. Rice Acres Treated with Selected Pesticides and the Estimated Impact on Production With and Without Alternatives

Pesticide	Treated Acres (percent)	Yield Impact With Alternative* (percent)	Production Impact With Alternative** (percent)	Yield Impact Without Alternative (percent)	Production Impact Without Alternative** (percent)
2,4-D	23.20	-2.50	-0.58	-29.38	-6.82
carbofuran	13.50	-7.13	-0.96	-13.75	-1.86
benomyl	24.30	-6.50	-1.58	-20.00	-4.86

* Numbers are based on the average yield impact across all states based on estimates provided by the responding specialists.

** The production impact is calculated by multiplying the percent of treated acres times the estimated yield impact on those treated acres.

Table 33. U.S. Rice Production, Baseline Projections Versus Proposed Changes in Pesticide Availability, 1996-2005

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Baseline (Mill. cwt.)	185.7	185.3	185.9	186.2	185.4	183.6	182.3	181.4	180.9	180.3
Alternatives Available:										
No 2,4-D	184.6	184.3	184.8	185	184.1	182.3	181.1	180.2	179.6	179.1
percent change	-0.58%	-0.56%	-0.59%	-0.66%	-0.70%	-0.71%	-0.69%	-0.69%	-0.69%	-0.69%
No carbofuran	183.9	183.7	184.2	184.2	183.3	181.5	180.3	179.4	178.9	178.3
percent change	-0.93%	-0.90%	-0.95%	-1.06%	-1.13%	-1.14%	-1.12%	-1.10%	-1.11%	-1.11%
No benomyl	183.4	183.4	183.8	183.8	182.9	181.1	179.8	179	178.4	177.9
percent change	-1.21%	-1.06%	-1.15%	-1.29%	-1.37%	-1.38%	-1.35%	-1.34%	-1.35%	-1.37%
No Alternatives:										
No 2,4-D	173	172.9	172.9	171.8	170.1	168.4	167.5	166.9	166.3	165.7
percent change	-6.82%	-6.69%	-6.99%	-7.74%	-8.25%	-8.30%	-8.12%	-8.01%	-8.03%	-8.10%
No carbofuran	182.3	182.1	182.5	182.4	181.4	179.6	178.4	177.6	177	176.5
percent change	-1.80%	-1.73%	-1.83%	-2.04%	-2.18%	-2.20%	-2.15%	-2.13%	-2.13%	-2.15%
No benomyl	178.7	179.2	179.3	178.8	177.6	175.8	174.7	173.9	173.3	172.7
percent change	-3.73%	-3.30%	-3.54%	-3.96%	-4.21%	-4.24%	-4.16%	-4.13%	-4.16%	-4.22%

Table 34. U.S. Rice Farm Price, Baseline Projections Versus Proposed Changes in Pesticide Availability, 1996 - 2005

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Baseline ($/cwt. rough)	6.66	7.11	7.44	7.56	7.53	7.6	7.76	8	8.21	8.43
Alternatives Available:										
No 2,4-D	6.71	7.16	7.45	7.55	7.53	7.6	7.77	8.01	8.22	8.44
percent change	0.82%	0.68%	0.22%	-0.03%	-0.01%	0.11%	0.17%	0.17%	0.15%	0.13%
No carbofuran	6.74	7.19	7.46	7.55	7.53	7.61	7.78	8.02	8.23	8.45
percent change	1.33%	1.09%	0.35%	-0.04%	-0.02%	0.17%	0.28%	0.27%	0.24%	0.21%
No benomyl	6.77	7.2	7.47	7.55	7.53	7.61	7.79	8.02	8.23	8.45
percent change	1.72%	1.28%	0.36%	-0.08%	-0.00%	0.23%	0.35%	0.34%	0.29%	0.27%
No Alternatives:										
No 2,4-D	7.3	7.69	7.63	7.51	7.51	7.69	7.92	8.16	8.34	8.56
percent change	9.70%	8.14%	2.60%	-0.55%	-0.28%	1.25%	2.09%	2.02%	1.68%	1.51%
No carbofuran	6.83	7.26	7.49	7.55	7.53	7.62	7.8	8.04	8.24	8.47
percent change	2.56%	2.11%	0.68%	-0.10%	-0.03%	0.34%	0.53%	0.52%	0.45%	0.41%
No benomyl	7.01	7.39	7.52	7.53	7.53	7.65	7.85	8.08	8.28	8.5
percent change	5.31%	3.96%	1.10%	-0.29%	-0.04%	0.72%	1.11%	1.05%	0.89%	0.82%

Table 35. U.S. Retail Price, Baseline Projections Versus Proposed Changes in Pesticide Availability, 1996-2005

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Baseline ($/cwt. milled)	39.35	40.82	42.56	44.2	45.44	46.44	47.54	48.97	50.29	51.84
Alternatives Available:										
No 2,4-D	39.48	41.07	42.75	44.27	45.45	46.45	47.57	49.01	50.33	51.87
percent change	0.34%	0.62%	0.45%	0.17%	0.02%	0.02%	0.06%	0.08%	0.08%	0.07%
No carbofuran	39.56	41.23	42.87	44.32	45.46	46.45	47.58	49.03	50.36	51.89
percent change	0.54%	1.00%	0.73%	0.28%	0.03%	0.03%	0.10%	0.14%	0.14%	0.11%
No benomyl	39.63	41.33	42.92	44.33	45.45	46.46	47.6	49.06	50.37	51.91
percent change	0.71%	1.24%	0.84%	0.29%	0.02%	0.04%	0.13%	0.18%	0.17%	0.14%
No Alternatives:										
No 2,4-D	40.93	43.85	44.88	45.05	45.46	46.47	47.88	49.49	50.78	52.21
percent change	4.00%	7.43%	5.46%	1.92%	0.04%	0.06%	0.72%	1.07%	0.97%	0.73%
No carbofuran	39.77	41.61	43.16	44.43	45.46	46.47	47.63	49.1	50.42	51.94
percent change	1.06%	1.94%	1.41%	0.52%	0.05%	0.05%	0.19%	0.27%	0.25%	0.20%
No benomyl	40.21	42.39	43.67	44.59	45.46	46.49	47.74	49.25	50.56	52.05
percent change	2.20%	3.84%	2.62%	0.88%	0.03%	0.09%	0.42%	0.58%	0.54%	0.42%

Table 36. Net Returns above Variable Costs, Baseline Projections Versus Proposed Changes in Pesticide Availability, 1996 - 2005

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Baseline ($/acre)	305	293.87	277.9	257.41	240.03	227.09	214.78	195.9	182.51	172.23
Alternatives Available:										
No 2,4-D	299.81	287.49	272.43	253.82	237.57	224.77	212.22	193.08	180.27	169.9
percent change	-1.70%	-2.17%	-1.97%	-1.39%	-1.03%	-1.02%	-1.19%	-1.44%	-1.23%	-1.35%
No carbofuran	296.65	283.56	269.18	251.59	236.15	223.47	210.65	191.39	178.93	168.5
percent change	-2.74%	-3.51%	-3.14%	-2.26%	-1.62%	-1.60%	-1.92%	-2.30%	-1.96%	-2.16%
No benomyl	294.13	281.09	267.34	250.4	235.1	222.19	209.23	189.77	177.6	167.1
percent change	-3.57%	-4.35%	-3.80%	-2.72%	-2.06%	-2.16%	-2.58%	-3.13%	-2.69%	-2.98%
No Alternatives:										
No 2,4-D	243.69	218.85	214.24	216.59	213.4	201.41	184.28	166.4	155.76	144.5
percent change	-20.10%	-25.53%	-22.91%	-15.86%	-11.10%	-11.31%	-14.20%	-15.06%	-14.66%	-16.10%
No carbofuran	288.8	274.02	261.02	246.36	232.66	220.08	206.82	187.14	175.58	165.04
percent change	-5.31%	-6.76%	-6.07%	-4.29%	-3.07%	-3.09%	-3.70%	-4.47%	-3.80%	-4.17%
No benomyl	271.4	254.68	245.45	236.18	225.26	212.42	197.53	177.66	167.34	156.37
percent change	-11.02%	-13.34%	-11.68%	-8.25%	-6.15%	-6.46%	-8.03%	-9.31%	-8.31%	-9.21%

years of the projection. The impact on farm price is greater if alternatives are not available. However, the trend is similar with increases of 9.70% and 8.14% in 1996 and 1997, respectively. Farm price in the remainder of the period ranges from a slight decrease from the baseline to a 2.60% increase.

The impact on consumers is estimated by the change in the U.S. retail rice price (Table 35). The retail price of rice after banning 2,4-D with alternatives available increases less than 1% through the projected time period. If alternatives are not available, retail prices increase approximately 4.00%, 7.43%, and 5.46% in 1996, 1997, and 1998, respectively. In years 1999 through 2005, retail price increases less than 2% over baseline.

Net returns above variable costs were used to estimate the impact on farm profitability as a result of changes in pesticide availability (Table 36). The percent change in net returns above variable costs ranges from 2.17% to 1.02% below baseline projections after banning 2,4-D with alternatives. However, the impact on net returns is substantial if no alternatives are available. In 1996 the market value of the U.S. rice crop increases 2.2% as a result of a higher farm price. However, the higher farm prices lowers government deficiency payments by 26.2%. This results in a 9.4% reduction of total income. Net returns decrease 20.10% below baseline in 1996, 25.53% in 1997, and 22.91% in 1998. Net returns range from 11% to 16% below baseline in the remainder of the period.

The consumer impact, producer impact, and the net impact were calculated for each scenario, and are included in the appendix. With alternatives available, banning 2,4-D resulted in a consumer impact ranging from –$12.69 million in 1996 to a $0.49 million increase in 1999. The producer impact ranged from a –$9.87 million in 2000 to $2.95 million in 1996. The net impact had a relatively small range of –$11.55 million in 2005 to –$8.88 million in 1998. As expected, banning 2,4-D without alternatives resulted in much larger impacts. The consumer impact ranged from –$145.82 million in 1996 to a $9.27 million increase in 1999. The producer impact ranged from –$118.69 million in 2000 to $27.48 million in 1996. The net impact ranged from –$131.07 million in 2005 to –$106.60 million in 1998. Banning 2,4-D without alternatives had a much larger negative impact than when alternatives are available.

ECONOMIC IMPACT RESULTING FROM A BAN ON CARBOFURAN

The projected change in production resulting from a ban on carbofuran with alternatives available is minimal. Production decreases range from .90% below baseline to 1.14% below baseline throughout the 1996-2005 period. Banning carbofuran without available alternatives results in a slightly larger decrease in production ranging from 1.73% to 2.20%. This translates into a 3.2 to 4.0 million cwt. reduction in rice production.

U.S. farm price is affected most in the first two years after banning carbofuran when alternatives are available. The farm price increases a modest 1.33% and 1.09% in 1996 and 1997, respectively. The impact is even less in the remaining years of the projection with farm price in two years being below the baseline projections. The impact on farm price is greater if alternatives are not available. However, the trend is similar with increases of 2.56% and 2.11% in 1996 and 1997, respectively. The change in farm price is minimal from 1998 through 2005.

The retail price of rice after banning carbofuran with alternatives available increased 1% or less through the projected time period. If alternatives are not available, retail prices increase approximately 1% to 2% above the baseline in the first three years. In years 1999 through 2005, retail price increases are minimal.

The percent change in net returns above variable costs ranges from 1.60% to 3.51% below baseline projections after banning carbofuran with alternatives. The impact on net returns is approximately doubled if no alternatives are available. In 1996 net returns per acre decrease $16.20/acre below baseline projections. Net returns were estimated to be $19.86/acre and $16.87/acre below baseline in 1997 and 1998, respectively. Net returns range from $7.37/acre to $8.76/acre below baseline in the remainder of the period.

When carbofuran is banned with alternatives available, the consumer impact ranges from –$20.39 million in 1996 to $0.72 million in 1999. The producer impact ranged from –$15.99 million in 2000 to $4.68 million in 1996. The net impact ranged from –$17.43 million in 2005 to –$14.31 million in 1998. When no viable alternative for carbofuran is available, the consumer impact ranges from –$39.25 million in 1996 to $1.67 million in 1999. The producer impact ranged from –$30.86 million in 2000 to $8.81 million in 1996. The net impact ranged from –$34.65 million in 2005 to –$27.70 million in 1998.

ECONOMIC IMPACT RESULTING FROM A BAN ON BENOMYL

The projected change in production resulting from banning benomyl with alternatives available is minimal. Production decreases range from 1.06% to 1.38% below baseline projections throughout the 1996-2005 period. However, banning benomyl without alternatives available results in a decrease in production ranging from 3.30% to 4.24%.

U.S. farm price is affected most in the first two years after banning benomyl when alternatives are available. The farm price increases 1.72% and 1.28% in 1996 and 1997, respectively. The impact is even less in the remaining years of the projection. The impact on farm price is greater if alternatives are not available. However, the trend is similar with increases of 5.31% and 3.96% in 1996 and 1997, respectively. Farm price in the remainder of the period range from a slight decrease from the baseline to a 1.11% increase.

The retail price of rice after banning benomyl with alternatives available increases no more than 1.24% throughout the projected time period. If alternatives are not available, retail prices increase 2.20% to 3.84% above the baseline in the first three years. In years 1999 through 2005, retail price increases less than 1% over baseline.

The percent change in net returns above variable costs ranges from 2.06% to 4.35% below baseline projections after banning benomyl with alternatives available. If alternatives are not available, the reduction in net returns is substantial. Net returns range from 6.15% to 13.34% below baseline in the projection period.

When alternatives are available, the banning of benomyl resulted in a consumer impact ranging from –$26.49 million in 1996 to $1.37 million in 1999. The producer impact ranged from –$19.18 million in 1999 to $6.05 million in 1996. The net impact varied from –$22.17 million in 2005 to –$17.11 million in 1998. When no alternatives are available, the consumer, producer, and net impacts are much larger as would be expected. The consumer impact ranged from –$80.83 million in 1996 to $4.97 million in 1999. The producer impact ranged from –$59.59 million in 1999 to $17.06 million in 1996. The net impact ranged from –$68.26 million in 2005 to –$53.01 million in 1998.

PESTICIDE SAFETY PRACTICES

The surveyed rice growers were questioned concerning the safety practices they use when handling pesticides. The growers were also asked about any pesticide applicator training sessions they had attended in the past few years. They were asked to rate the session and to list any changes they had made in their pesticide handling practices as a result of attending the session.

Approximately 70 percent of the responding growers reported attending a pesticide applicator training session in the last 3-4 years. Twenty-five percent of these growers rated the training session as "excellent", 58 percent rated it as "good", 13 percent rated it as "fair", and 4 percent rated the session as "poor".

When the growers were asked if they had changed any of their pesticide practices as a result of attending the training session, 48 percent responded "yes". The changes listed and the percentage of responding growers listing each change are as follows:

Wear more protective gear	39%
Read labels more closely	36%
More careful in general	19%
More careful with calibration	10%
Observed pest thresholds before spraying	5%
Properly clean and dispose of pesticide containers	2%
Watch weather conditions closely	2%
Stress safety to employees	1%
Improved recordkeeping	1%
Using less pesticide with better timing	1%
Use commercial applicators	1%
Change application procedures	1%
Use ground applications instead of aerial	1%

The following list contains the safety measures reported as being used regularly by the responding rice growers when handling or applying pesticides:

Goggles	28%
Rubber gloves	49%
Rubber boots	28%
Long sleeve shirt	46%
Tractor with cab	27%

The rice growers reported that they obtained most of their pesticide information from the following sources:

Pesticide dealer	62%
County Extension agent	43%
Commercial consultant	16%
Farm magazine	12%
Neighbor	8%
Other	9%

When asked where they would prefer to obtain new information about pesticides the growers gave the following responses:

Fact sheets	63%
Magazines	18%
Meetings	42%
Newspapers	3%
Radio	3%
Television	3%
Update letters	59%

SUMMARY

Managing the pests of rice requires both chemical and non-chemical approaches. Although the non-chemical approaches are an important part of managing rice pests, economical control often depends on the use of pesticides. Pesticides are essential in controlling certain weeds, diseases and insects. Over 80 pesticide products are labeled for use on rice, representing approximately 30 different active ingredients. The highest use pesticides (i.e., propanil, molinate, 2,4-D, bensulfuron, benomyl, methyl parathion, and carbofuran) account for approximately 70 percent of the total pounds of pesticide active ingredient applied to U.S. rice acreage each year (15,397,835 pounds a.i. in 1993). For these seven pesticides, and for rice pesticides in general, there are usually alternatives (chemical and/or non-chemical) that can be used for controlling a pest problem if the particular pesticide was not available for use on rice.

In most cases the use of alternative pest control strategies impacts various aspects of overall rice production. The rice specialists indicated that in many cases the most immediate impact would be increased costs or reduced efficacy when using alternatives. It stands to reason that rice growers would, in most cases, already be using the most economical (cost and efficacy) pest control methods. Therefore most alternatives would likely cost more and/or be less effective. The rice specialists though, indicated that for a small number of pesticides such as, iprodione, the use of alternatives could actually boost yields which could offset any increase in the price of control.

Alternatives for specific pesticides could also impact rice production by increasing the number of pesticide active ingredients, or applications, required to control a given pest. The rice weed specialists indicated that losing one of the high use herbicides for rice would necessitate the use of multiple herbicide active ingredients to provide pest control similar to the lost herbicide. Pesticide alternatives that are less efficacious than the "lost" pesticide could lead to a buildup of pest densities. The rice weed specialists repeatedly noted this type of impact. They stressed that the yield reduction due to losing a pesticide would increase in subsequent years as the seed bank increases for the weed(s) normally controlled by the "lost " herbicide.

The rice specialists indicated there are no effective alternatives to carbofuran and benomyl which are critical to rice production. Carbofuran is essential in controlling the rice water weevil, a significant pest in virtually all rice production areas. Both specialists and growers indicated that any alternatives to carbofuran did not, or would not, provide satisfactory control of the rice water weevil. This is significant because granular carbofuran (the formulation used on rice) is scheduled to lose its registration for rice on September 1, 1997, due to perceived bird mortality problems. With no reliable alternatives and without prospects for new pesticides for controlling rice water weevil this situation will require increased additional research effort if rice water weevil is to be economically managed.

It should be noted that although losing carbofuran would result in a relatively small economic impact across all rice producing states (see Economic Assessment), in certain states (i.e., California and Louisiana) the impact would be proportionally greater. This is due to the large

percentage of acres treated with carbofuran in these two states.

Benomyl for rice blast control is another pesticide that has no reliable alternatives according to rice specialists. Although sheath blight is a greater problem from year-to-year, blast has a greater potential to cause significant yield loss in certain years. In addition, the rice blast pathogen has shown the ability to develop "races" which allows it to overcome host resistance developed through breeding programs. The use of benomyl for rice disease control could be in jeopardy because this use is impacted by Section 409 of the Federal Food, Drug and Cosmetic Act (FFDCA), also known as the Delaney Clause. In general, this regulation prohibits the concentration of carcinogenic pesticides in processed foods which can occur while processing raw agricultural commodities into food products. Although only rice seed hulls are specifically affected by the Delaney Clause, the Environmental Protection Agency's "coordination policy" could require that all benomyl uses for rice be cancelled. This would leave rice growers without a reliable means of controlling blast. In addition to benomyl, iprodione use on rice could also be affected by the Delaney Clause. The final decisions concerning the Delaney Clause and related pesticide cancellations have yet to be made. (However, at the time of this writing, EPA is proposing to eliminate the Section 409 tolerance for benomyl as unnecessary so that the Delaney Clause would not affect benomyl use on rice.)

The loss of pesticides not only affects yields and pest population dynamics but also crop quality. Besides being an effective, inexpensive broadleaf herbicide, 2,4-D is also important in controlling weeds that have seeds similar in size to rice seed i.e., hemp sesbania, northern jointvetch, and morningglories. The presence of these seeds in the harvested rice results in discounts of the price paid to the grower because of increased cleaning costs and limited markets for the contaminated rice.

The results of the economic assessment indicate that rice producers and consumers would be affected by the banning of 2,4-D, carbofuran, and benomyl. The negative impact on production, farm price, retail price, and net returns appear to be minimal when alternatives are available. However, it should be noted that this economic assessment does not account for the cumulative pressure from pests that may result from several years of rice production without pesticides. Conversely, the economic assessment does not account for future technological advances. This assumption is justified given the length of time required for product development and registration.

The impact on the rice industry is more significant if 2,4-D, carbofuran, and benomyl are banned and no alternatives are available. Production would decrease, resulting in an increase in farm price. However, the increased farm price would not compensate for less product to sell. Also as farm price increases, deficiency payments decrease. The consequence is a substantial reduction in net returns above variable costs.

With few new rice pesticides being developed the push has been to use the various pest control methods now available in new or modified ways to provide better pest control. Reduced rates of pesticides coupled with a higher level of crop/pest management, better implementation of existing thresholds, timing of applications (i.e., delayed preemergence), variety selection, and other management practices have been used to enhance the control of rice pests with relative success. These practices and integrated pest management (IPM) techniques are stressed at most rice grower educational meetings conducted each year by state Extension Services. Many of the surveyed growers reported using these pest management techniques.

The continued availability of important rice pesticides and the use of other pest management practices are critical to maintaining rice yields and quality. The loss of one or more of the critical rice pesticides discussed in the report could significantly affect rice production in the United States and force many rice growers out of business. More research is needed to determine additional management methods for the pests that are controlled by only one pesticide if that pesticide has a chance of losing its registration on rice.

LITERATURE CITED

1. Baldwin, F.L. 1988. Benefits of Using Bromoxynil for Broadleaf Weed Control in Rice. Unpublished.

2. Bernhardt, J. L. 1995. Screening for Rice Stink Bug resistance, pp. 60-63. In B. R. Wells (ed.), Rice Research Studies 1994. Ark. Agric. Exp. Stn. Res. Series 446.

3. The Biologic and Economic Assessment of Carbofuran - A Report of the Carbofuran Assessment Team to the Special Review of Carbofuran. 1989. USDA in Cooperation with State Agricultural Experiment Station, Cooperative Extension, Other State Agencies, and U.S. Environmental Protection Agency. Submitted to EPA on December 22, 1989.

4. Brorsen, B.W., W.R. Grant, and M.E. Rister. 1984. A Hedonic Price Model for Rough Rice Bid/Acceptance Markets. American Journal of Agricultural Economics. 66:156-163

5. Cartwright, R.D., F.N. Lee, D.L. Crippen and G.E. Templeton. 1993. Monitoring of Rice Diseases Under Different Locations and Cultural Practices in Arkansas. Arkansas Rice Research Studies 1993. Arkansas Agricultural Experiment Station, Division of Agriculture, University of Arkansas. Research Series 439.

6. Crop Production and Prospective Plantings, March 1994. National Agricultural Statistics Service, USDA. Acreage, June 1994, NASS, USDA.

7. Dillman, D.A. 1978. Mail and Telephone Surveys: The Total Design Method. John Wiley and Sons, New York. 325 pages.

8. Facts About USA Rice. Published by USA Rice Council. 1994.

9. Integrated Pest Management for Rice, Second Edition. 1993. University of California, Statewide Integrated Pest Management Project, Division of Agriculture and Natural Resources, Publication 3280.

10. Managing Rice for Ducks - Youth Activity/4-H Project. 1995. Cooperative Extension Service, University of Arkansas.

11. Musick, J.A. (editor), F.N. Lee, G.L. Cloud, D.E. Groth, C.A. Hollier, D. Caillavet, J.P. Krausz. 1993. Benomyl Benefits Assessment on Rice in the Southern United States. Submitted to the Environmental Protection Agency, Public Response and Program Resources Branch, Field Operations Division (H7506C), Office of Pesticide Programs, April 1, 1993.

12. Rice Production Handbook, MP 192. 1994. Cooperative Extension Service, University of Arkansas.

13. 1993 Rice Production Guidelines, D-1253. Texas Agricultural Extension Service, Texas A&M University.

14. Smith, R.J., Jr., W.T. Flinchum, and D.E. Seaman. 1977. Weed Control in U.S. Rice Production. Agriculture Handbook No. 497. USDA, Washington, D.C. 78 pages.

15. Smith, R.J., Jr. 1988. Weed Thresholds in Southern U.S. Rice, *Oryza sativa*. Weed Technology. Volume 2:232-241.

16. Wailes, E. J., G. L. Cramer, and S. Fan. 1994. Arkansas Rice Model: International Baseline Projections for 1994. Arkansas Agricultural Experiment Station, University of Arkansas. Special Report 164, November, 1994.

WEEDS – ALPHABETICALLY BY COMMON NAME

Weed – Common Name	*Weed – Scientific Name*
Algae	*Various genera*
Alligatorweed	*Alternanthera philoxeroides*
Ammannia (Redstem)	*Ammannia coccinea*
Arrowhead (California)	*Sagittaria montevidensis*
Arrowhead (Common)	*Sagittaria latifolia*
Arrowhead (Gregg's)	*Sagittaria longiloba*
Barnyardgrass (Watergrass in certain states)	*Echinochloa crusgalli*
Black Rice	*Unknown*
Broadleaf Signalgrass	*Brachiaria platyphylla*
Bromegrass	*Bromus sp.*
Cocklebur	*Xanthium strumarium*
Crabgrass	*Digitaria ischaemum (Smooth), D. sanguinalis (Large), D. ciliaris (Southern)*
Dayflower (Commelina)	*Commelina communis or C. diffusa*
Ducksalad	*Heteranthera limosa*
Eclipta	*Eclipta prostrata*
Fall Panicum	*Panicum dichotomiflorum*
Fan Sedge (Hoorahgrass)	*Fimbristylis sp.*
Foxtail	*Setaria sp.*
Gooseweed	*Sphenoclea zeylandica*
Groundcherry	*Physalis angulata*
Hemp sesbania (Coffeebean)	*Sesbania exaltata*
Johnsongrass	*Sorghum halepense*
Mannagrass	*Unknown*
Morningglory	*Ipomea sp.*
Northern Jointvetch (Curly indigo)	*Aeschynomene virginica*
Pickerelweed	*Pontederia cordata*
Red Rice	*Oryza sativa*
Redweed	*Melochia corchorifolia*
Ricefield Bulrush (Roughseed Bulrush)	*Scirpus mucronatus*
River Bulrush	*Scirpus fluviatilis*
Sedge (Annual)	*Cyperus sp.*
Smallflower Umbrellaplant	*Cyperus difformis*
Smartweed	*Polygonum lapathifolium (Pale), P. pensylanicum (Pennsylvania),*
Sprangletop (Amazon)	*Leptochloa panicoides*
Sprangletop (Bearded)	*Leptochloa fasicularis*
Sprangletop (Red)	*Leptochloa filiformis*
Texasweed (Mexicanweed)	*Caperonia palustrus*
Water Berry	*Unknown*
Watergrass (Early)	*Echinochloa oryzoides*
Watergrass (Late)	*Echinochloa oryzicola*
Water Hyssop	*Bacopa rotundifolia*
Yellow Nutsedge	*Cyperus esculentus*

WEEDS – ALPHABETICALLY BY SCIENTIFIC NAME

Weed – Scientific Name	Weed – Common Name
Aeschynomene virginica	Northern Jointvetch (Curly Indigo)
Alternanthera philoxeroides	Alligatorweed
Ammannia coccinea	Ammannia (Redstem)
Bacopa rotundifolia	Water Hyssop
Brachiaria platyphylla	Broadleaf Signalgrass
Bromus sp.	Bromegrass
Caperonia palustrus	Texasweed (Mexicanweed)
Commelina communis	Asiatic Dayflower
Cyperus difformis	Smallflower Umbrellaplant
Cyperus esculentus	Yellow Nutsedge
Cyperus sp.	Sedges
Digitaria ciliaris	Southern Crabgrass
Digitaria ischaemum	Smooth Crabgrass
Digitaria sanguinalis	Large Crabgrass
Echinochloa crusgalli	Barnyardgrass, Red Top
Echinochloa oryzicola	Watergrass (Late)
Echinochloa oryzoides	Watergrass (Early)
Eclipta prostrata	Eclipta
Fimbristylis miliacea	Fan Sedge, Hoorahagrass
Heteranthera limosa	Ducksalad
Ipomea sp.	Morningglory
Leptochloa fasicularis	Sprangletop (Bearded)
Leptochloa filiformis	Sprangletop (Red)
Leptochloa panicoides	Sprangletop (Amazon)
Melochia corchorifolia	Redweed
Oryza sativa	Red Rice
Panicum dichotomiflorum	Fall Panicum
Physalis angulata	Groundcherry
Polygonum lapathifolium	Pale Smartweed
Polygonum pensylanicum	Pennsylvania Smartweed
Pontederia cordata	Pickerelweed
Sagittaria latifolia	Common Arrowhead
Sagittaria longiloba	Gregg's Arrowhead
Sagittaria montevidensis	California Arrowhead
Scirpus fluviatilis	River Bulrush
Scirpus mucronatus	Ricefield Bulrush (Roughseed Bulrush)
Sesbania exaltata	Hemp Sesbania (Coffeebean)
Setaria sp.	Foxtail
Sorghum halepense	Johnsongrass
Sphenoclea zeylandica	Gooseweed
Xanthium strumarium	Cocklebur

DISEASES – ALPHABETICALLY BY COMMON NAME

Disease – Common Name	Disease – *Scientific Name*
Bacterial Leaf Blight	*Xanthomonas campestris pv. oryzae*
Black Sheath Rot	*Gaumannomyces graminis*
Brown Leaf Spot	*Cochliobolus miyabeanus (Helminthosporium oryzae)*
Kernel Smut	*Tilletia barclayana*
Leaf Smut	*Entyloma oryzae*
Narrow Brown Leafspot	*Sphaerulina oryzina (Cercospora janseana)*
Rice Blast	*Pyricularia grisea*
Sheath Blight	*Thanatephorus cucumeris (Rhizoctonia solani)*
Sheath Spot	*Rhizoctonia oryzae-sativae*
Stem Rot	*Magnaporthe salvinii (Sclerotium oryzae)*
Water Mold	*Achyla sp.*
Water Mold	*Phytophthora sp.*
Water Mold	*Pythium sp.*

DISEASES – ALPHABETICALLY BY SCIENTIFIC NAME

Disease – *Scientific Name*	Disease – Common Name
Achyla sp.	Water Mold
Cochliobolus miyabeanus (Helminthosporium oryzae)	Brown Leaf Spot
Entyloma oryzae	Leaf Smut
Gaumannomyces graminis	Black Sheath Rot
Magnaporthe salvinii (Sclerotium oryzae)	Stem Rot
Phytophthora sp.	Water Mold
Pyricularia grisea	Rice Blast
Pythium sp.	Water Mold
Rhizoctonia oryzae-sativae	Sheath Spot
Sphaerulina oryzina (Cercospora janseana)	Narrow Brown Leafspot
Thanatephorus cucumeris (Rhizoctonia solani)	Sheath Blight
Tilletia barclayana	Kernel Smut
Xanthomonas campestris pv. oryzae	Bacterial Leaf Blight

INSECTS – ALPHABETICALLY BY COMMON NAME

Insect – Common Name	Insect – *Scientific Name*
Armyworm	*Pseudaletia unipuncta*
Chinch Bug	*Blissus leucopterus leucopterus*
Crayfish	*Orconectes virilis*
Crayfish	*Procambarus clarki*
Fall Armyworm	*Spodoptera frugiperda*
Grasshopper	*Family: Acrididae*
Rice Leaf Miner	*Hydrellia griseola*
Rice Seed Midge	*Family: Chironomidae*
Rice Stalk Borer	*Chilo plejadellus*
Rice Stink Bug	*Oebalus pugnax*
Rice Water Weevil	*Lissorhoptrus oryzophilus*
Sugarcane Borer	*Diatraea saccharalis*
Tadpole Shrimp	*Triops longicaudatus*

INSECTS – ALPHABETICALLY BY SCIENTIFIC NAME

Insect – *Scientific Name*	Insect – Common Name
Family: Acrididae	Grasshopper
Blissus leucopterus leucopterus	Chinch Bug
Chilo plejadellus	Rice Stem Borer
Family: Chironomidae	Rice Seed Midge
Diatraea saccharalis	Sugarcane Borer
Hydrellia griseola	Rice Leaf Miner
Lissorhoptrus oryzophilus	Rice Water Weevil
Oebalus pugnax	Rice Stink Bug
Orconectes virilis	Crayfish
Procambarus clarki	Crayfish
Pseudaletia unipuncta	Armyworm
Spodoptera frugiperda	Fall Armyworm
Triops longicaudatus	Tadpole Shrimp

ACTIVE INGREDIENT/PRODUCT NAME OF RICE PESTICIDES

Active Ingredient	Product Name(s)
2,4-D	Various formulations
acifluorfen	Blazer, Storm
Bacillus thuringiensis	Dipel, Thuricide, Javelin and other formulations
benomyl	Benlate
bensulfuron	Londax
bentazon	Basagran, Storm
bromoxynil	Buctril
captan	Various formulations
carbaryl	Sevin (4F, 50W, 80S, XLR Plus)
carbofuran	Furadan (3G, 5G)
carboxin	Vitavax 200 and various other formulations
copper sulfate	Various formulations
cyhalothrin	Karate
etridiazole	Terraclor Super X
fenoxaprop	Whip
gibberellic acid	Release, Ryzup, ProGibb
glyphosate	Roundup
malathion	Various formulations
mancozeb	Dithane (DF, F-45, M-45), Manzate 200, Penncozeb
MCPA	Rhomene, Rhonox, Chiptox
metalaxyl	Apron (25W, FL), Ridomil (2E, 50W)
methyl parathion	Various formulations
molinate	Ordram (10G, 15G), Arrosolo
paraquat	Gramoxone Extra
PCNB	Terraclor (2EC, 75W)
pendimethalin	Prowl 3.3EC
propanil	Stam (4E, M-4), Wham, Strel 4E, Arrosolo
propiconzole	Tilt
quinclorac	Facet
sethoxydim	Poast, Poast Plus
TCMTB	Nusan 30
thiobencarb	Bolero (10G, 8EC)
thiram	Thiram 42-S
triclopyr	Grandstand

APPENDIX

APPENDIX A.

Sample Grower Survey

USE OF PESTICIDES IN THE 1993 RICE CROP:
A SURVEY OF LOUISIANA PRODUCERS

This survey is one of several we are doing to determine pesticide use patterns on the major agricultural crops in Louisiana. The information collected will provide the basis for defending the use and maintaining the continued availability of chemicals important to Louisiana crop production. Please answer all of the questions. If you wish to comment on any questions or qualify your answers, please feel free to use the space in the margins. Your comments will be read and taken into account.

Thank you for your help.

Louisiana State University
Louisiana Cooperative Extension Service
Agricultural Center
Baton Rouge, Louisiana

The term "pesticide" in this questionnaire includes any chemical used to control weeds, insects, diseases, and nematodes as well as harvest aids.

Q-1 Did you use any pesticides (herbicides, fungicides, insecticides, etc.) on your 1993 rice crop? (Circle one)

1 NO

2 YES

(If no) Since our purpose is to find out what kinds of pesticides were used on rice in 1993, we would like you to answer only the questions with a star (★) by them (Questions 2-7, 11, 12, 18-21, 27-30, 36-43). Then please return the questionnaire to us in the business reply envelope provided.

★Q-2 What is the total number of acres that you farm?

__________ ACRES

★Q-3 How many acres of rice did you plant in 1993?

__________ ACRES

★Q-4 How many acres of your rice were planted by:

WATER-SEEDED __________ ACRES

DRY BROADCAST __________ ACRES

DRILL-SEEDED __________ ACRES

★Q-5 How many of your rice acres were planted on the following soil types?

CLAY __________ ACRES

SILT LOAM __________ ACRES

SANDY LOAM __________ ACRES
OTHER (Please specify) _____________ _____________ ACRES

★Q-6 What were the rice varieties you planted in 1993 and how many acres were planted with each variety?

_____________ VARIETY _____________ ACRES

_____________ VARIETY _____________ ACRES

_____________ VARIETY _____________ ACRES

_____________ VARIETY _____________ ACRES

★Q-7 What was your average rice yield per acre (dry weight) in 1993? Please do not include ratoon rice yields.

_____________ BUSHELS

(OR)

_____________ BARRELS

Q-8 Did your 1993 rice seed receive a fungicide seed treatment?

1 NO

2 YES

(If no) Please skip to Q-11

Q-9 How many acres of your 1993 rice crop was grown using treated seed?

_____________ PERCENT

Q-10 Please indicate the kind of seed treatment used in 1993 and the number of acres on which treated rice seed was planted with any of the seed treatments listed below.

Seed Treated With	Acres Used On
Apron FL	____________
Apron 25W	____________
Champion SD	____________
Dithane F-45	____________
Dithane DF	____________
Gustafson 42S	____________
Kocide SD	____________
Manex II	____________
Manzate 200 DF	____________
Vitavax 200 FF	____________
Other (Please specify)	
______________________	____________

Now we would like to ask some questions about diseases in your 1993 rice crop.

★Q-11 What disease(s) caused the greatest money loss in your 1993 rice crop? (If none, write NONE.) A list of common rice diseases is given in Q-12 and on the last page of the questionnaire.

____

____

★Q-12 Please estimate how much of your 1993 rice acreage was affected by the following diseases or physiological conditions.

Disease	Acres Affected	Disease	Acres Affected
Sheath Blight	______	Narrow Brown Leaf Spot	______
Blast	______	Water Molds (Achlya, Pythium)	______
Stem Rot	______	Other (List)	
		______	______
Straighthead	______	______	______
Brown Leaf Spot	______	______	______

Q-13 Did you use any fungicides to control diseases in your 1993 rice crop? (Circle one)

1 NO

2 YES

(If no) Skip to Q-18

Q-14 How much of your 1993 rice acreage was treated at least once with a fungicide to control diseases?

______ ACRES

Q-15 Please indicate the fungicides used to control diseases in your 1993 rice crop, the acres treated with each fungicide, the disease(s) you were trying to control with each fungicide, the number of applications, and the rate per acre. Also, please estimate the quality of control given by the product you used (0-25% control = POOR; 25-50% control = FAIR; 50-75% control = GOOD; 75-100% control = EXCELLENT). A complete list of fungicides is on the next to last page of the questionnaire.

Fungicide (Brand Name)	Acres Treated	Targeted Diseases	Number of Applic.	Rate Per Acre	Quality of Control
Benlate					
Tilt					
Rovral 4F					
Rovral WP					
Other (List)					

Q-16 If any of the fungicide applications listed in Q-15 were made as tank mixes could you please list all the pesticides (insecticides, fungicides, and herbicides) contained in each tank mix and the number of acres to which that combination was applied.

Pesticides Used in Each Tank Mix Acres Trt

1. ____________ + ____________ + ______________ __________

2. ____________ + ____________ + ______________ __________

3. ____________ + ____________ + ______________ __________

4. ____________ + ____________ + ______________ __________

Q-17 For the same fungicides listed in Q-15, please estimate the cost per acre for each fungicide application **(if a fungicide was part of a tank mix then give the application cost and write TM to indicate a tank mix)**, the method of application (ground or aerial), and the timing of application(s), Example: at internode elongation (green ring), at 50% heading, or at 90% heading, etc.

Fungicide (Brand Name)	Chemical Cost/Acre	Application Cost/Acre	Method of Application (Ground or Aerial)	Timing of Application
Benlate				
Tilt				
Rovral 4F				
Rovral WP				
Other				

★Q-18 Did you use something besides chemicals (fungicides) to control diseases of your 1993 rice crop, such as: biologicals, cultural practices, resistant varieties, or chemicals other than pesticides? (Circle one)

1 NO

2 YES

(If no) skip to Q-20

★Q-19 Please list the alternatives to fungicides mentioned in Q-18, the acres treated with each alternative, the disease(s) you were trying to control, the estimated cost per acre, and whether the alternative provided poor, fair, good, or excellent control of the targeted disease.

Alternative Control Method	Acres Treated	Disease(s) You Were Trying to Control	Cost Per Acre	Quality of Control

Now we would like to ask some questions about insects in your 1993 rice crop.

★Q-20 What insect caused the greatest money loss in your 1993 rice crop? (If none, write NONE) A list of the common rice insects is given in Q-21 and on the last page of the questionnaire.

____

____

★Q-21 Please estimate how much of your 1993 rice acreage was infested with the following insects.

Insect	Acres Infested	Insect	Acres Infested
Aphids	________	Rice Seed Midge	________
Armyworms	________	Rice Water Weevil	________
Chinch Bugs	________	Southern Green Stinkbug	________
Grasshoppers	________	Other (List)	
Rice Leaf Miner	________	_______________	________
Rice Stink Bug	________	_______________	________

Q-22 Did you use any insecticides to control insects in your 1993 rice crop? (Circle one)

1 NO

2 YES

(If no) Skip to Q-27

Q-23 How much of your 1993 rice acreage was treated at least once with an insecticide to control insects?

_______________ ACRES

Q-24 Please indicate the insecticides used to control insects in your 1993 rice crop, the acres treated with each insecticide, the insect(s) you were trying to control with each insecticide, the number of applications, and the rate per acre. Also, please estimate the quality of control given by the product you used (0-25% control = POOR; 25-50% control = FAIR; 50-75% control = GOOD; 75-100% control = EXCELLENT). A complete list of insecticides is on the next to the last page of the questionnaire.

Insecticide (Brand Name)	Acres Treated	Insect(s) You Were Trying to Control	Number of Applic.	Rate Per Acre	Quality of Control
Furadan 3G					
Methyl Parathion					
Penncap M					
Malathion 57EC					
Sevin 4F					
Sevin 50W					
Sevin 80S					
Sevin XLR Plus					
Other (List)					

Q-25 For the same insecticides listed in Q-24, please estimate the cost per acre for each insecticide application **(if a insecticide was a part of a tank mix then give the application cost and write TM to indicate a tank mix)**, the method of application (ground or aerial), and the timing of application(s). Example: as needed or 14 days before or after propanil application, etc.

Insecticide (Brand Name)	Chemical Cost/Acre	Application Cost/Acre	Method of Applic.(Ground or Aerial)	Timing of Applic.
Furadan 3G				
Methyl Parathion				
Penncap M				
Malathion 57EC				
Sevin 4F				
Sevin 80S				
Sevin XLR Plus				
Other (List)				

Q-26 If any of the insecticide applications listed in Q-24 were made as tank mixes could you please list all the pesticides (insecticides, fungicides, and herbicides) contained in each tank mix and the number of acres to which that combination was applied. There is no need to list the tank mixes already listed in Q-16.

Pesticides Used in Each Tank Mix — Acres Trt

1. ____________ + ____________ + ______________ __________

2. ____________ + ____________ + ______________ __________

3. ____________ + ____________ + ______________ __________

4. ____________ + ____________ + ______________ __________

★Q-27 Did you use something besides insecticides to control insects of your 1993 rice crop, such as: biologicals (Dipel or B.t.), cultural practices, or chemicals other than pesticides? (Circle one)

1 NO

2 YES

(If no) Skip to Q-29

★Q-28 Please list the alternatives to insecticides mentioned in Q-27, the acres treated with each alternative, the insect(s) you were trying to control, the estimated cost per acre, and whether the alternative provided poor, fair, good, or excellent control of the targeted insect.

Alternative Control Method	Acres Treated	Insect(s) You Were Trying to Control	Cost Per Acre	Quality of Control

Now we would like to ask some questions about weeds in your 1993 rice crop.

★Q-29 What weed caused the greatest money loss in your 1993 rice crop? (If none, write NONE) A list of the common rice weeds is given in Q-30 and on the last page of the questionnaire.

____

____

★Q-30 Please estimate how much of your 1993 rice acreage was infested with the following weeds.

Weed	Acres Infested	Weed	Acres Infested
Alligatorweed	________	Sedges (Annual)	________
Barnyardgrass	________	Yellow Nutsedge	________
Dayflower	________	Sprangletop	________
Ducksalad	________	Texasweed (Birdeye)	________
Hemp Sesbania	________	Waterhyssop	________
Jointvetch (Curly indigo)	________	Signalgrass	________
Red Rice	________	Mannagrass	________
Redstem	________	Other (List)	
		____________	________
		____________	________

Q-31 Did you use any herbicides to control weeds in your 1993 rice crop? (Circle one)

1 NO

2 YES

(If no) Skip to Q-36

Q-32 How much of your 1993 rice acreage was treated at least once with a herbicide to control weeds?

________________ ACRES

Q-33 Please indicate the herbicides used to control weeds in your 1993 rice crop, the acres treated with each herbicide, the weed(s) you were trying to control with each herbicide, the number of applications, and the rate per acre. Also, please estimate the quality of control given by the product you used (0-25% control = POOR; 25-50% control = FAIR; 50-75% control = GOOD; 75-100% control = EXCELLENT) A complete list of herbicides is on the next to last page of the questionnaire.

Herbicide (Brand Name)	Acres Treated	Weed(s) You Were Trying to Control	Number of Applic.	Rate Per Acre	Quality of Control
2,4-D Amine					
2,4-D Dacamine					
Arrosolo 3-3E					
Basagran					
Blazer 2L					
Bolero 8EC					
Bolero 10G					
Londax 60DF					
Grandstand					
Facet					
MCPA					
Ordram 15G					
Ordram 8E					
Prowl					
Propanil (Stam)					
Whip					
Roundup (preplant)					
Gramoxone (preplant)					
Other (List)					

Q-34 For the same herbicides listed in Q-33, please estimate the cost per acre for each herbicide application **(if a herbicide was a part of a tank mix then give the application cost and write TM to indicate a tank mix)**, the method of application (ground or aerial), and the timing of application(s), i.e., preplant incorporated, delayed preemerge, leaf stage of rice, in full flood, etc.

Herbicide (Brand Name)	Chemical Cost/Acre	Application Cost/Acre	Method of Applic.(Ground or Aerial)	Timing of Applic.
2,4-D Amine				
2,4-D Dacamine				
Arrosolo 3-3E				
Basagran				
Blazer 2L				
Bolero 8EC				
Bolero 10G				
Londax 60DF				
Grandstand				
Facet				
MCPA				
Ordram 15G				
Ordram 8E				
Prowl				
Propanil (Stam)				
Whip				
Roundup (preplant)				
Gramoxone (preplant)				
Other (List)				

Q-35 If any of the herbicide applications listed in Q-33 were made as tank mixes could you please list all the pesticides (insecticides, fungicides, and herbicides) contained in each tank mix and the number of acres to which that combination was applied. There is no need to list the tank mixes already listed in Q-16 and Q-26.

Pesticides Used in Each Tank Mix			Acres Treated
1. ____________	+ ____________	+ ______________	__________
2. ____________	+ ____________	+ ______________	__________
3. ____________	+ ____________	+ ______________	__________
4. ____________	+ ____________	+ ______________	__________

★Q-36 Did you use something besides herbicides to control weeds of your 1993 rice crop, such as: biologicals, cultural practices, or chemicals other than pesticides? (Circle one)

1 NO

2 YES

(If no) Skip to Q-38

★Q-37 Please list the alternatives to herbicides mentioned in Q-36, the acres treated with each alternative, the weed(s) you were trying to control, the estimated cost per acre, and whether the alternative provided poor, fair, good, or excellent control of the targeted weed.

Alternative Control Method	Acres Treated	Weed(s) You Were Trying to Control	Cost Per Acre	Quality of Control

★Q-38 Did you attend a pesticide applicator certification and/or training session in 1990, 1991, 1992 or 1993? (Circle one)

1 NO

2 YES

(If no) Skip to Q-41

★Q-39 How valuable would you rate the information presented at the training session? (Circle one)

1 EXCELLENT
2 GOOD
3 FAIR
4 POOR

★Q-40 Did you change any of your pesticide practices as a result of attending the training session? Examples: read the label more closely; calibrate equipment better; wear additional protective gear.

1 NO

2 YES

(If yes) Please briefly describe the changes you made as a result of attending the training session in the space below.

____

____

★Q-41 Do you use any of the following as a regular precaution when handling or applying pesticides? (Circle those that apply)

1 GOGGLES OR FACE SHIELD
2 RUBBER GLOVES
3 RUBBER BOOTS
4 LONG SLEEVE CLOTHING
5 USE A TRACTOR WITH CAB

★Q-42 Where do you get most of your information about the proper pesticide to use on your rice crop? (Circle one)

1 PESTICIDE DEALER
2 COUNTY AGENT
3 COMMERCIAL CONSULTANT
4 FARM MAGAZINE
5 NEIGHBOR
6 OTHER (List)______________________________

____

★Q-43 How would you prefer to get new information about pesticides? (Circle those that apply)

1 FACT SHEETS
2 MAGAZINES
3 MEETINGS
4 NEWSPAPERS
5 RADIO
6 TELEVISION
7 UPDATE LETTERS

TRADE NAMES OF COMMONLY USED RICE PESTICIDES IN LOUISIANA (1993)

HERBICIDES

2,4-D Amine
2,4-D Dacamine
Arrosolo 3-3E
Basagran
Blazer 2L
Bolero 8EC
Bolero 10G
Facet
Gramoxone
Grandstand
Londax 60DF
MCPA
Ordram 15G
Ordram 8E
Propanil (Stam)
Prowl
Roundup
Whip

FUNGICIDES

Benlate DF
Rovral 4F
Rovral WP
Tilt

SEED TREATMENTS

Apron FL
Apron 25WP
Champion SD
Dithane F-45
Dithane DF
Gustafson 42S
Kocide SD
Manex II
Manzate 200 DF
Vitavax 200FF

INSECTICIDES

B.t. (Bacillus thuringiensis)
Dipel
Furadan 3G
Malathion 57EC
Methyl Parathion
Penncap M
Sevin 4F
Sevin 50W
Sevin 80S
Sevin XLR Plus

COMMON PEST PROBLEMS OF LOUISIANA RICE

INSECTS

Aphids
Armyworms
Chinch Bugs
Grasshoppers
Rice Leaf Miner
Rice Seed Midge
Rice Stink Bug
Rice Water Weevil
Southern Green Stinkbug

DISEASES

Blast
Brown Leaf Spot
Narrow Brown Leaf Spot
Seedling Blight
Sheath Blight
Stem Rot
Straighthead
Water Molds (Achlya, Pythium)

WEEDS

Alligatorweed
Barnyardgrass
Dayflower
Ducksalad
Eclipta
Fimbrystilis
Gooseweed
Hemp Sesbania
Jointvetch (Curly indigo)
Mannagrass
Red Rice
Redstem
Sedges (Annual)
Signalgrass
Spikerush
Sprangletop
Texasweed (Birdeye)
Waterhyssop
Yellow Nutsedge

Is there anything else you would like to tell us about the use of agricultural chemicals in rice? If so, please use the space below for that purpose.

Also, any comments you wish to make that you think may help us in future efforts to collect pesticide use information on Louisiana crops will be appreciated either in the space below or in a separate letter.

Your contribution to this effort is very greatly appreciated. If you would like a summary of the results, please print your name and address on the back of the return envelope (NOT ON THIS QUESTIONNAIRE). We will see that you get it.

APPENDIX B.

Grower Survey Results From the Participating States

RESULTS OF 1992 ARKANSAS
RICE GROWER PESTICIDE USE SURVEY

Number of Growers Surveyed: 500

Number of Growers Responding: 212 (42% response rate)

Total Rice Acres Reported: 73,475

Drill Seeded: 68%
Dry Broadcast: 29%
Water Seeded Acres: 2%

Soil Types: Silt Loam - 55%; Clay - 35%; Sandy Loam - 9%

Average Yield Per Acre: 129 Bushels

Table 1. Reported Varieties

Variety	Percentage of Total Surveyed Acres	Variety	Percentage of Total Surveyed Acres
Katy	20.3	Nortai	0.6
Newbonnet	19.6	Texmont	0.5
Lemont	19.2	Gulfmont	0.4
Alan	15.8	Jackson	0.3
Millie	7.8	Della	0.2
Mars	5.9	VX 716	0.2
Tebonnet	2.2	Jasmine 85	0.2
Orion	1.1	RT 7015	0.2
L202	1.0	Rosemont	0.1
Maybelle	0.9	Labelle	0.1
Lacassine	0.9	Rico 1	0.05

WEED CONTROL

Table 2. Weeds Listed as Causing the Greatest Money Loss

Weed	As Percentage of Growers Listing the Weed	Weed	As Percentage of Growers Listing the Weed
Barnyardgrass	36.0	Grass (not specified)	3.3
Red Rice	16.6	Cocklebur	0.95
Morningglory	14.2	Indian Jointvetch	0.95
Hemp Sesbania (coffeebean)	12.3	Dayflower (water parsley)	0.5
Sprangletop	9.5	Aquatics (not specified)	0.5
Northern Jointvetch (curly indigo)	9.0	Fall Panicum	0.5
Nutsedge	5.2	Groundcherry	0.5
Ammannia (redstem)	5.2	Johnsongrass	0.5
Ducksalad	5.7	Water Hyssop	0.5
Smartweed	3.8	Crabgrass	0.5
Broadleaf Signalgrass	3.3		

Approximately 27 percent of the growers indicated that no weed caused a "great" economic loss to their rice crop.

Acres Treated with Herbicides: 69,032 (94% of total acres).

Table 3. Herbicides Used, Percentage of Acres Treated, Average Number of Applications, Average Rate, Targeted Weeds, and Estimated Quality of Control.

Herbicide	% of Total Acres Treated	Avg. # of Applic.	Avg. Rate/A	Targeted Weed(s) with % of Growers Listing the Weed	Quality of Control as % of Growers Responding
Propanil (includes Stam, Wham, and generic) (173 responses)	67.6	1.5	3.3 qts or 4.5 lbs of dry form.	All grass - 90; Broadleaves - 18; All weeds - 9; Unknown - 8	**All grass:** Exc.-23, Good-47, Fair-22, Poor-3, Unknown-5 **All Broadleaves:** Exc.-16, Good-50, Fair-31, Poor-3 **All weeds:** Exc.-31, Good-56, Fair-6, Unknown-6
2,4-D (67 responses)	22.4	1.0	1.5 pt	Morningglory - 58; Hemp Sesbania - 37; Other Broadleaves - 55; Unknown - 7	**Morningglory:** Exc.-46, Good-42, Fair-6, Poor-1, Unknown-6 **Hemp Sesbania:** Exc.-44, Good-48, Fair-4, Unknown-4 **Other Broadleaves:** Exc.-46, Good-38, Fair-8, Poor-3, Unknown-5 **Unknown:** Unknown
Ordram (15G & 8E) (50 responses)	8.6	1.0	23.3 lb or 1 qt of 8E	Barnyardgrass-50; Other Grass-50; Smartweed-6; Unknown-14.0	**Barnyardgrass:** Exc.-24, Good-48, Fair-16, Poor-4, Unknown-8 **Other Grass:** Exc.-20, Good-56, Fair-16, Poor-4, Unknown-4 **Smartweed:** Good-100 **Unknown:** Unknown
Bolero (43 responses)	13.7	1.1	2.3 pt	Sprangletop - 21; Barnyardgrass - 19; Other Grass - 37; Broadleaves - 49	**Sprangletop:** Exc.-22, Good-56, Fair-11, Unknown-11 **Barnyardgrass:** Exc.-11, Good-67, Fair-11, Unknown-11 **Other Grass:** Exc.-25, Good-69, Unknown-6 **Broadleaves:** Exc.-33, Good-38, Fair-10, Poor-19
Facet (37 responses)	11.6	1.0	0.76 lb	All Grass - 78; Broadleaves - 24; All Weeds - 14; Unknown - 8	**All Grass:** Exc.-55, Good-38, Fair-3, Unknown-4 **Broadleaves:** Exc.-44, Good-33, Unknown-22 **All Weeds:** Exc.-60, Good-20, Fair-20
Arrosolo (37 responses)	18.5	1.2	3.7 qt	Barnyardgrass - 35; Other Grass - 57; Broadleaves - 52; Unknown - 11	**Barnyardgrass:** Exc.-39, Good-31, Fair-23, Unknown-8 **Other Grass:** Exc.-38, Good-29, fair-24, Poor-5, Unknown-5 **Broadleaves:** Exc.-54, Good-15, Fair-15, Poor-8, Unknown-8
Prowl (29 responses)	10.5	1.0	1.8 pt	Barnyardgrass - 31; Other Grass - 62	**Barnyardgrass:** Exc.-20, Good-60, Fair-20 **Other Grass:** Exc.-22, Good-61, Fair-11, Poor-6
Buctril (28 responses)	6.8	1.0	1.02 pt	Morningglory - 32; Other Broadleaves - 86	**Morningglory:** Exc.-44, Good-22, Fair-22, Poor-11 **Other Broadleaves:** Exc.-38, Good-46, Fair-13, Unknown-4

Blazer (26 responses)	3.8	1.0	0.92 pt	Hemp Sesbania - 58; Morningglory - 23; Other Broadleaves - 19	**Hemp Sesbania:** Exc.-13, Good-73, Fair-7, Unknown-7 **Morningglory:** Good-50, Fair-17, Unknown-33 **Other Broadleaves:** Good-60, Poor-20, Unknown-20
Grandstand (23 responses)	5.7	1.0	1.04 pt	Morningglory - 39; Northern Jointvetch - 35; Hemp Sesbania - 22; Other Broadleaves - 43	**Morningglory:** Exc.-33, Good-44, Fair-22 **Northern Jointvetch:** Exc.-25, Good-63, Unknown-13 **Hemp Sesbania:** Exc.-40, Good-60 **Other Broadleaves:** Exc.-20, Good-30, Fair-40, Poor-10
Whip (22 responses)	3.2	1.0	0.97 pt	Sprangletop - 50; Other Grasses - 50	**Sprangletop:** Exc.-36, Good-46, Poor-18 **Other Grass:** Exc.-25, Good-25, Fair-17, Poor-33
Basagran (18 responses)	1.5	1.0	1.65 pt	Smartweed - 33; Nutsedge - 33; Cocklebur - 22; Other Broadleaves - 50	**Smartweed:** Exc.-50, Good-33, Fair-17 **Nutsedge:** Exc.-17, Good-33, Fair-50 **Cocklebur:** Exc.-25, Good-50, Fair-25 **Other Broadleaves:** Good-56, Unknown-44
Londax (5 responses)	1.2	1.0	0.79 oz	Nutsedge - 100	**Nutsedge:** Exc.-80, Good-20
Dacamine (2 responses)	0.5	1.5	1.5 pt	Broadleaves - 100	**Broadleaves:** Exc.-50, Unknown-50
Roundup (3 responses)	0.7	1.0	1.0 pt	All Weeds - 100 (preplant burndown)	**All Weeds:** Exc.-33, Good-33, Unknown-33

Table 4. Herbicide Costs, and Methods of Application

Herbicide	Avg. Cost/A for Each Application*	Method of Application
Propanil	$21.35	Aerial - 87%, Ground - 4%, Unknown - 9%
2,4-D	$ 6.59	Aerial - 67%, Ground - 21%, Unknown - 12%
Ordram	$24.74 for 15G $8.75 for 8E	Aerial - 88%, Ground - 2%, Unknown - 10%
Bolero	$17.36	Aerial - 79%, Ground - 5%, Unknown - 17%
Facet	$26.37	Aerial - 89%, Ground - 9%, Unknown - 3%
Arrosolo	$20.91	Aerial - 83%, Ground - 8%, Unknown - 8%
Prowl	$ 6.68	Aerial - 83%, Unknown - 17%
Buctril	$10.75	Aerial - 82%, Unknown - 19%
Blazer	$ 9.34	Aerial - 80%, Ground - 4%, Unknown - 16%
Grandstand	$11.42	Aerial - 82%, Unknown - 19%
Whip	$17.91	Aerial - 86%, Ground - 5%, Unknown - 10%
Basagran	$12.05	Aerial - 77%, Ground - 6%, Unknown - 18%
Londax	$ 8.86	Aerial - 100%
Dacamine	$ 6.77	Aerial - 100%
Roundup	$ 9.46	Aerial - 100%

* Includes application costs of roughly $4.00 to $4.50 per acre.

Approximately 8 percent of the growers reported using alternatives to herbicides for controlling weeds. The growers reported using these alternatives on approximately 7 percent of the total acres. Note: There must have been some confusion with the question because virtually all rice acres are grown using flood water as a non-chemical weed control method.

Table 5. Alternative Weed Control Methods, Percentage of Acres Treated with Each Method, Targeted Weeds, and Quality of Control.

Alternative Method	% of Acres Treated	Targeted Weeds with % of Growers Listing the Weed	Quality of Control as % of Growers Responding
Water Management	4.2	All weeds - 33; Red Rice - 50; Barnyardgrass - 25; Morningglory - 8	**All Weeds:** Exc.-75, Good-25 **Red Rice:** Exc.-33, Good-17, Fair-33, Poor-17 **Barnyardgrass:** Good-33, Fair-33, Poor-33 **Morningglory:** Unknown
Crop Rotation	0.9	All Weeds - 50; Northern Jointvetch - 50	**All Weeds:** Fair **Northern Jointvetch:** Fair
Minimum/No-Till	0.8	Coffeebean - 50; Northern Jointvetch - 50; Ducksalad - 50; Red Stem - 50	**Coffeebean:** Good **Northern Jointvetch:** Good **Ducksalad:** Good **Red Stem:** Good
Hand Weeding	0.4	Barnyardgrass - 50, Broadleaves - 50, Grass - 50	**Barnyardgrass:** Poor **Broadleaves:** Poor **Grass:** Exc.
Water Seeding	0.4	Red Rice - 100; Barnyardgrass - 50; Broadleaf Signalgrass - 50	**Red Rice:** Exc.-50, Poor-50 **Barnyardgrass:** Poor **Broadleaf Signalgrass:** Poor
Collego	0.1	All Weeds (only has activity on Northern Jointvetch)	**All Weeds:** Exc.
Grass Hook (?)	0.08	Barnyardgrass	Unknown

DISEASE CONTROL

Approximately 58 percent of the growers reported using seed treatments. The acres planted with treated seed equaled 38% of the total acres surveyed.

Table 6. Seed Treatments by Active Ingredient

Seed Treatment	As Percentage of Acres Planted with Treated Seed
gibberellic acid	69.8
carboxin	49.3
mancozeb	9.4
metalaxyl	2.6
etridiazole + PCNB	1.7
TCMTB	0.7

Table 7. Acres Reported as Being Affected/Infected by Various Diseases.

Disease	As Percentage of Total Surveyed Rice Acres
Sheath Blight	26.3
Rice Blast	8.8
Straighthead*	1.2
Black Rot	0.9
Stem Rot	0.2
Kernel Smut	0.2
Seedling Disease (not specified)	0.2

Table 8. Diseases Listed as Causing the Greatest Money Loss.

Disease	Percentage of Growers Listing the Disease
Sheath Blight	46.9
Blast	24.4
Straighthead*	2.4
Stem Rot	0.5
Kernel Smut	0.5

* Straighthead is not a true disease but a physiological disorder.

Note: Approximately 41% of the growers indicated that no disease caused a "great" economic loss to their rice crop.

Acres Treated With Fungicides: 29,067 (39.6% of total surveyed acres)

Table 9. Fungicides Used, Percentage of Acres Treated, Average Number of Applications, Average Rate, Targeted Diseases, and Estimated Quality of Control.

Fungicide	% of Total Acres Treated	Avg. # of Applic.	Avg. Rate/A	Targeted Disease(s) with % of Growers Listing the Disease	Quality of Control as % of Growers Responding
Benlate (78 responses)	23.7	1.3	1.05 lb	Blast - 76; Sheath Blight - 41; All Diseases - 1	**Blast:** Exc.-12, Good-37, Fair-25, Poor-2; Unknown-24 **Sheath Blight:** Exc.-16, Good-58, Fair-26 **All Diseases:** Good-100
Tilt (26 responses)	10.1	1.2	9.5 oz	Sheath blight - 96; Blast - 4	**Sheath blight:** Exc.-20, Good-36, Fair-36, Poor-8 **Blast:** Fair-100
Rovral (20 responses)	5.5	1.1	1.0 lb dry or 1.2 pt of 4L	Sheath blight - 100.0; Blast - 5	**Sheath Blight:** Exc.-15, Good-45, Fair-25, Poor-5, Unknown-10 **Blast:** Good-100

Table 10. Fungicide Costs, and Methods of Application.

Fungicide	Average Cost/Acre for Each Application*	Method of Application
Benlate	$19.06	Aerial - 100%
Tilt	$25.38	Aerial - 100%
Rovral	$21.52	Aerial - 100%

* Includes application costs of roughly $4.00 to $4.50 per acre.

Approximately 22 percent of the growers reported using alternatives to fungicides for controlling diseases. The growers reported using these alternatives on approximately 11 percent of the total acres.

Table 11. Alternative Disease Control Methods, Percentage of Acres Treated with Each Method, Targeted Diseases, and Quality of Control.

Alternative Method	% of Acres Treated	Targeted Diseases with % of Growers Listing the Disease	Quality of Control as % of Growers Responding
Resistant Varieties (34 responses)	5.5	Sheath blight - 50; Blast - 38; Straighthead - 12; Unknown - 9	**Sheath blight:** Good-53, Fair-6, Unknown-41 **Blast:** Exc.-31, Good-39, Fair-15, Unknown-15 **Straighthead:** Good-100
Water Management (8 responses)	2.8	Blast - 88; Unknown - 13	**Blast:** Exc.-43, Good-29, Poor-14, Unknown-14 **Unknown:** Unknown
Thinner Stand (4 responses)	2.1	Blast - 50; Unknown - 50	**Blast:** Fair-50, Unknown-50 **Unknown:** Unknown
Ammonium Sulfate* (1 response)	0.3	All Diseases	Excellent

INSECT CONTROL

Table 12. Insects Listed as Causing the Greatest Money Loss.

Insect	Percentage of Growers Listing the Insect
Stinkbug	21.9
Grasshopper	7.6
Rice Water Weevil	6.2
Armyworm	4.3
Rice Stem Borer	1.4
Chinchbug	0.5

Note: Approximately 71% of the growers indicated that no insect caused a "great" economic loss to their rice crop.

Acres Treated With Insecticides: 6,869 (9.4% of total acres)

Table 13. Insecticides Used, Percentage of Acres Treated, Average Number of Applications, Average Rate, Targeted Insects, and Estimated Quality of Control.

Insecticide	% of Total Acres Treated	Avg. # of Applic.	Avg. Rate/A	Targeted Insect(s) with % of Growers Listing the Insect	Quality of Control as % of Growers Responding
Malathion (12 responses)	3.5	1.1	0.89 pt	Stinkbug - 50; Grasshopper - 33; Armyworm - 25; Chinchbug - 8	**Stinkbug:** Exc.-17, Good-67, Unknown-16 **Grasshopper:** Exc-25, Good-57, Unknown-18 **Armyworm:** Good-50, Poor-50 **Chinchbug:** Exc.-100
Methyl Parathion (13 responses)	5.3	1.0	1.1 pt	Armyworm - 31; Stinkbug - 69; Grasshopper - 31	**Armyworm:** Exc.-50, Good-50 **Stinkbug:** Exc.-33, Good-44, Poor-11, Unknown-11 **Grasshopper:** Exc.-50, Good-25, Poor-25
Furadan 3G (3 responses)	0.9	1.0	19 lbs	Rice Water Weevil - 100	Exc.-67, Good-33
Sevin (1 response)	0.3	1.0	Unknown	Stinkbug	Good
Penncap M (1 response)	0.2	1.0	2.5 pt	Stinkbug and Grasshopper	Excellent

Table 14. Insecticide Costs, and Methods of Application

Insecticide	Average Cost/Acre for Each Application*	Method of Application
Malathion	$ 5.97	Aerial - 92%, Ground - 8%
Methyl Parathion	$ 6.99	Aerial - 100%
Furadan 3G	$16.53	Aerial - 100%
Sevin	Unknown	Unknown
Penncap M	Unknown	Unknown

* Includes application costs of roughly $4.00 to $4.50 per acre.

Approximately 2 percent of the growers reported using alternatives to insecticides for controlling insects. The growers reported using these alternatives on approximately 3 percent of the total acres.

Table 15. Alternative Insect Control Methods, Percentage of Acres Treated with Each Method, Targeted Insects, and Quality of Control.

Alternative Method	% of Acres Treated	Targeted Insects with % of Growers Listing the Insect	Quality of Control as % of Growers Responding
Drain field (5 responses)	2.7	Rice Water Weevil - 100.0	Exc.-40, Good-40, Unknown-20

Approximately 47 percent of the growers reported attending a pesticide applicator training session in the past four years. They rated the session as follows:

Excellent - 24%
Good - 60%
Fair - 12%
Poor - 4%

When asked if they changed any of their pesticide practices as a result of attending the session, approximately 52 percent responded "yes". The changes listed and the percentage of growers listing each change are as follows:

Wear more protective gear - 34%
Read labels more closely - 29%
More careful in general - 14%
More careful calibration - 16%
Change application procedures - 3.3%

Growers were asked to indicate which precautions or protective gear they used when handling pesticides. The responses and the percentage of growers listing each response are as follows:

Goggles - 11%
Rubber gloves - 28%
Rubber boots - 11%
Long sleeve shirt - 24%
Tractor with cab - 26%

Growers were asked where they obtained most of their information about the proper use of pesticides. The responses and the percentage of growers listing each response are as follows:

Pesticide dealer - 54%
County agent - 57%
Commercial consultant - 14%
Farm magazine - 17%
Neighbor - 10%
Other - 4%

Finally, growers were asked where they would prefer to obtain new information about pesticides. The responses and the percentage of growers listing each response are as follows:

Fact sheets - 68%
Magazines - 22%
Meetings - 41%
Newspapers - 3%
Radio - 4%
Television - 5%
Update letters - 61%

COMMENTS FROM RICE GROWERS

- Bad stand in our rice led to increased chemical costs plus cost of spot seeding. We jumped the gun by getting our rice broadcast with the promise of rain. We didn't get enough rain for a stand and didn't get the field flushed in time.

- Need control for red rice.

- Whip treatment killed rice.

- Carryover from chemical damage from the year before was our greatest problem.

- Need to keep 2,4-D for economical control of broadleaves in rice.

- Killed all the grasses and rice with Whip application on 170 acres.

- 1) Most applications of chemical on rice is done aerially. I feel more emphasis should be placed on preventing farmers from forcing aerial applicators to apply chemicals under adverse conditions. 2) Please do not remove a chemical that does not show considerable risk to humans until a replacement can be found. Example: Furadan on rice water weevil. 3) Finally, the risk of human health must be weighed equally against the economic impact that results from the loss of an important chemical.

- Better grass control needed. More effective fungicides. Chemical cost containment.

- Proper timing has helped me more than anything else with my weed and grass problems. Proper water management during early mid-season has helped control my sheath blight problems really well. When the disease shows up drop your water level as low as you can stand. Check field daily and apply 1 to 1 1/2 lbs Benlate. One application has seemed to work good for me. With this practice I went from cutting 80 bushels per acre to 120 or 130. That kind of results more than pays its own way.

- Chemicals are a necessity if we are to be productive and efficient. Hopefully with proper application, handling, and disposal, we can avert any extreme measures to limit rice chemicals.

- I feel we do not appreciate our local Extension Service enough - until we have problems and call them - even after hours.

- No economic losses great enough to report form any disease in 1992. Whip treatment killed rice in spots.

- High cost - When the government payment is cut out there won't be very much rice grown.

- Keep us informed about rates and characteristics of chemicals and the cut-off dates before harvest.

- If ag chemicals continue to be banned we will not be able to make a decent crop. Therefore, we will not be able to make income sufficient to sustain agriculture as we know it today.

- We are concerned about the environment and the health of our employees as well as ourselves. Should have used Benlate and Tilt on 20-30 acres. Used malathion in grain bins to kill off insects before we put the rice in bins. Levees were sprayed with Stam and Buctril also with fair control.

- We can't live without them (pesticides) and we all need to start telling the public what a cheap and safe food we really have - 1 ppt (part per trillion) isn't very much - we need talk about the risk benefit and how cheap food let's us enjoy the highest standard of living in the world.

- Heavy rice damage from Whip application.

- I wonder why the 2,4-D formulation Dacamine was taken off the market. It is still labeled for rice. I have found this to be excellent in controlling all black seeded plants, mainly indian jointvetch.

- 2,4-D should be outlawed in cotton country. Our farm has been raising rice for 12 years now, and not once have we used the product 2,4-D. We have a large acreage of cotton in Chicot county, and we have been damaged every year now by this product 2,4-D. We will have 300 acres of rice this year and we will never use this product.

- Get across to the EPA that having more chemicals available to the farmer does not mean more total pounds of chemicals will be used. For example, if Buctril is not available I will have to use Basagran preflood and 2,4-D midseason to control morningglory and smartweed. Whereas Buctril preflood gives excellent control with one application. Lots of luck.

- Have the research centers test chemicals that can take the place of banned chemicals so the EPA can approve them sooner. The EPA should work with these centers instead of against them.

- I need to know better ways to control blast and best chemicals for barnyardgrass problems.

- Sheath blight damage was minimal this year.

- I have both rice and cotton on my farm and would like to have more regulation on 2,4-D applicators. Every year there is thousands of acres of cotton damaged, from light to extremely heavy, by the drift of 2,4-D.

- We need something to control morningglory at midseason.

Table 16. Arkansas Acres Treated and Total Pounds Per Acre by Pesticide Active Ingredient

Common Name	Total Acres Treated - Survey	% of Total Acres	Total Acres Treated - Arkansas	Rate/Acre (lbs ai)	Total Pounds of Active Ingredient - Arkansas
2,4-D	16,791	22.9	320,040	0.75	240,352
acifluorfen	2,792	3.8	53,200	0.23	12,236
benomyl	17,417	23.7	331,800	0.53	174,195
bensulfuron	906	1.2	16,800	0.03	494
bentazon	1,136	1.5	21,000	0.83	17,430
bromoxynil	5,024	6.8	95,200	0.26	24,752
carbaryl	200	0.3	4,200	Unknown	Unknown
carbofuran	650	0.9	12,600	0.57	7,182
fenoxaprop	2,349	3.2	44,800	0.12	5,376
iprodione	4,074	5.5	77,000	0.5	38,500
malathion	2,547	3.5	49,000	0.56	27,440
methyl parathion	4,005	5.5	77,000	0.55	42,560
molinate	19,923	27.1	379,400	2.99	1,133,020
pendimethalin	7,738	10.5	147,000	0.9	132,300
propanil	63,220	86.1	1,205,000	3.2	3,862,068
propiconazole	7,452	10.1	141,400	0.27	38,178
quinclorac	8,537	11.6	162,400	0.38	61,712
thiobencarb	10,055	13.7	114,800	2.3	264,040
triclopyr	4,191	5.7	79,800	0.39	31,122

RESULTS OF 1993 CALIFORNIA
RICE GROWER PESTICIDE USE SURVEY

Number of Growers Surveyed: 315

Number of Growers Responding: 85 (27% response rate)

Total Rice Acres Reported: 39,382

Water Seeded Acres: 97%
Drill Seeded: 3%

Soil Types: Clay - 86%; Silt Loam - 7%; Sandy Loam - 6%

Average Yield Per Acre: 87.5 hundredweight

Table 1. Reported Varieties

Variety	Percentage of Total Acres
M 202	56.6
M 201	11.8
M 401	7.7
M 204	6.5
M 103	4.4
Kokuho	3.7
Calmochi	2.7
S 201	1.9
Calpearl	1.2
Calrose	0.8
KRM2	0.6
L 202	0.5
Akita	0.4
M 115	0.3

Table 2. Acres Reported as Being Infested with Various Weeds.

Weed	As Percentage of Total Rice Acres
Watergrass	22.8
Smallflower Umbrellaplant	16.8
Barnyardgrass	16.5*
Algae	15.2
California Arrowhead	11.9
Sprangletop	9.2
Ducksalad	8.1
Gregg's Arrowhead	6.1
River Bulrush	5.3
Ammannia (Redstem)	5.0
Water Hyssop	4.5
Ricefield Bulrush	3.5
Smartweed	2.5

* Doubtful - this is due to a lack of knowing the difference between barnyardgrass and watergrass (by growers). Barnyardgrass rarely grows in water-seeded rice (James E. Hill, personal communication).

Table 3. Weeds Listed as Causing the Greatest Money Loss

Weed	Percentage of Growers Listing the Weed
Watergrass	34.1
Smallflower Umbrellaplant	12.9
Sprangletop	9.4
Ricefield Bulrush	7.1
Barnyardgrass	5.9
Algae	2.4
Arrowhead	2.4
Ammannia (Redstem)	2.4
California Arrowhead	1.2
Broadleaves (not specified)	1.2
Bromegrass	1.2
Roughseed Bulrush	1.2
Sedge (not specified)	1.2

Note: Approximately 33 percent of the growers indicated no weed caused a "great" economic loss to their rice crop.

Acres Treated with Herbicides: 38,588 (98% of total acres).

Table 4. Herbicides Used, Percentage of Acres Treated, Average Number of Applications, Average Rate, Targeted Weeds, and Estimated Quality of Control.

Herbicide	% of Total Acres Treated	Avg. # of Applic.	Avg. Rate/A	Targeted Weed(s) with % of Growers Listing the Weed	Quality of Control as % of Growers Responding
Londax (79 responses)	83.4	1.0	1.38 oz	Sedges-30.4; Broadleaves-26.6; Bulrush-17.7; Smallflower Umbrellaplant-16.5; Arrowhead-11.4; Ducksalad-6.3; Watergrass-6.3; Redstem-2.5; All weeds-2.5; Barnyardgrass-1.3; Water Hyssop-1.3; Lily-1.3; Sprangletop-1.3; Unknown-6.3	**Sedges:** Exc.-41.7, Good-45.8, Fair-4.2, Unk.-8.3 **Broadleaves:** Exc.-42.9, Good-42.9, Fair-4.8, Unk.-9.5 **Bulrush:** Exc.-21.4, Good-50.0, Fair-14.3, Poor-7.1, Unk.-7.1 **Smallflower Umbrellaplant:** Exc.-38.5, Good-61.5 **Arrowhead:** Exc.-44.4, Good-33.3, Fair-11.1, Poor-11.1 **Ducksalad:** Exc.-60.0, Good-40.0 **Watergrass:** Exc.-80.0, Unk.-20.0 **Redstem:** Exc.-50.0, Fair-50.0 **All weeds:** Good-100.0 **Barnyardgrass:** Good **Water Hyssop:** Exc. **Lily:** Exc. **Sprangletop:** Fair **Unknown:** Good-20.0, Fair-20.0, Unk.-60.0
Ordram 10G (71 responses)	74.5	1.0	37.5 lbs	Watergrass-78.9; Barnyardgrass-15.5; Sprangletop-4.2; Broadleaves-2.8; Grass-2.8;Sedges-1.4; Unknown-5.6	**Watergrass:** Exc.-53.6, Good-33.9, Fair-8.9, Unk.-3.6 **Barnyardgrass:** Exc.-36.4, Good-63.6 **Sprangletop:** Exc.-33.3, Good-33.3, Fair-33.3 **Broadleaves:** Exc.-50.0, Unk.-50.0 **Grass:** Exc.-100.0 **Sedges:** Unknown **Unknown:** Good-50.0, Unknown-50.0
Bolero (24 responses)	17.2	1.0	37.9 lbs	Watergrass-45.8; Barnyardgrass-20.8; Sprangletop-12.5; Smallflower Umbrellaplant-8.3; Bulrush-4.2; Rice Weeds-4.2; Sedges-4.2; Broadleaves-4.2; Unknown-8.3	**Watergrass:** Exc.-45.5, Good-36.4, Unk.-18.2 **Barnyardgrass:** Good-60.0, Fair-40.0 **Sprangletop:** Exc.-66.7, Unk.-33.3 **Smallflower Umbrellaplant:** Exc.-50.0, Good-50.0 **Bulrush:** Exc. **Rice Weeds:** Exc. **Sedges:** Unk. **Broadleaves:** Unk. **Unknown:** Fair-50.0, Unk.-50.0
Copper Sulfate (23 responses)	14.6	1.0	11.5 lbs	Algae-91.3; Sedges-4.3; Broadleaves-4.3; Unknown-4.3	**Algae:** Exc.-28.6, Good-38.1, Fair-23.8, Poor-4.8, Unk.-4.8 **Sedges:** Unk. **Broadleaves:** Unk. **Unknown:** Exc.
MCPA (27 responses)	11.4	1.0	1.2 pts	Arrowhead-25.9; Smallflower Umbrellaplant-22.2; Redstem-14.8; Bulrush-11.1; Broadleaves-11.1; California Arrowhead-7.4; Lily (Arrowhead?)-7.4; Ducksalad-3.7; Smartweed-3.7; Sedges-3.7; Sprangletop-3.7; Unknown-3.7	**Arrowhead:** Exc.-28.6, Good-42.9, Fair-28.6 **Smallflower Umbrellaplant:** Exc.-16.7, Good-16.7, Fair-50.0, Unk.-16.7 **Redstem:** Exc.-25.0, Good-50.0, Fair-25.0 **Bulrush:** Exc.-66.7, Fair-33.3 **Broadleaves:** Good-100.0 **California Arrowhead:** Good-100.0 **Lily:** Exc.-100.0 **Ducksalad:** Fair **Smartweed:** Good **Sedges:** Unk. **Sprangletop:** Fair **Unknown:** Unk.

2,4-D (12 responses)	4.7	1.1	0.99 pt	Arrowhead-25.0; Broadleaves-25.0; Bulrush-16.7; Smallflower Umbrellaplant-16.7; Sedge-16.7; California Arrowhead-8.3; Ducksalad-8.3;	**Arrowhead:** Exc.-66.7, Fair-33.3 **Broadleaves:** Exc.-33.3, Good-33.3, Unknown-33.3 **Bulrush:** Exc.-50.0, Fair-50.0 **Smallflower Umbrellaplant:** Exc.-50.0, Fair-50.0 **Sedge:** Fair-50.0, Unknown-50.0 **California Arrowhead:** Good **Ducksalad:** Fair
Ordram 8E (4 responses)	4.6	1.0	3.97 pt	Watergrass-50.0; Barnyardgrass-25.0; Unknown-25.0	**Watergrass:** Exc.-50.0, Good-50.0 **Barnyardgrass:** Good **Unknown:** Good
Abolish (4 responses)	0.9	1.0	2.0 qts	Watergrass-75.0; Sprangletop-25.0; Unknown-25.0	**Watergrass:** Exc.-33.3, Good-33.3, Poor-33.3 **Sprangletop:** Poor **Unknown:** Exc.
Stam (3 responses)	0.7	1.0	1.0 gal	Bulrush-66.7; Watergrass-33.3	**Bulrush:** Exc.-50.0, Fair-50.0 **Watergrass:** Exc.
Roundup (preplant burndown) (2 responses)	0.2	1.0	Unk.	River Bulrush-50.0; Unknown-50.0	**River Bulrush:** Fair **Unknown:** Unknown
Poast (1 response)	0.03	1.0	Unk.	Watergrass	Unknown

Table 5. Herbicide Costs, and Methods of Application

Herbicide	Avg. Chemical Cost/Acre for Each Application	Avg. Application Cost/Acre for Each Application	Method of Application
Londax	$21.19	$3.52	Aerial - 67.1%, Unknown - 32.9%
Ordram 10G	$21.68	$4.54	Aerial - 73.2%, Ground - 1.4%, Unknown - 25.4%
Bolero	$20.20	$3.61	Aerial - 75.0%, Unknown - 25.0%
Copper Sulfate	$6.26	$3.25	Aerial - 77.4%, Unknown - 22.6 %
MCPA	$4.12	$3.63	Aerial - 74.1%, Ground - 3.7% Unknown - 22.2%
2,4-D	$2.12	$3.92	Aerial - 58.3%, Ground - 8.3% Unknown - 33.3%
Ordram 8E	$16.27	$1.10	Aerial - 50.0%, Ground - 50.0%,
Abolish	$25.33	$5.31	Aerial - 50.0%, Ground - 25.0% Unknown - 25.0
Stam	$12.50	$8.50	Aerial - 66.7%, Unknown - 33.3%
Roundup	Unknown	Unknown	Unknown
Poast	Unknown	Unknown	Unknown

Approximately 17 percent of the growers reported using alternatives to herbicides for controlling weeds. The growers reported using these alternatives on approximately 14 percent of the total acres. Note: There must have been some confusion with the question because virtually all rice acres are grown using flood water as a non-chemical weed control method. In addition, the responding California rice growers indicated that 97 percent of the rice acreage was water seeded which helps reduce the weed pressure from a number of weeds.

Table 6. Alternative Weed Control Methods, Percentage of Acres Treated with Each Method, Targeted Weeds, and Quality of Control.

Alternative Method	% of Acres Treated	Targeted Weeds with % of Growers Listing the Weed	Quality of Control as % of Growers Responding
Deep Water (11 responses)	9.7	Watergrass-45.5; Broadleaves-9.1; All Weeds-27.3; Sprangletop-9.1; Barnyardgrass-9.1; Sedge-9.1	**Watergrass:** Exc.-20.0, Good-20.0, Fair-20.0, Unknown-40.0 **Broadleaves:** Unknown **All Weeds:** Good-66.7, Fair-33.3 **Sprangletop:** Good **Barnyardgrass:** Good **Sedge:** Fair
Crop Rotation (2 responses)	1.8	Sedge-50.0; Broadleaves-50.0; All Weeds-50.0	**Sedge:** Exc. **Broadleaves:** Exc. **All Weeds:** Good
Cultural Practices (not named) (2 responses)	2.4	All Weeds-50.0; Broadleaves-50.0	**All Weeds:** Good **Broadleaves:** Good

DISEASE CONTROL

Table 7. Acres Reported as Being Affected/Infected by Various Diseases.

Disease	As Percentage of Total Rice Acres
Stem Rot	8.7
Aggregate Sheath Spot	1.2
Seed Rot or Seedling Diseases	0.2
Kernel Smut	0.1
Helminthosporium Brown Leaf Spot	0.04

Table 8. Diseases Listed as Causing the Greatest Money Loss.

Disease	Percentage of Growers Listing the Disease
Stem Rot	25.0
Sheath Spot	1.3

Note: Approximately 74% of the growers indicated that no disease caused a "great" economic loss to their rice crop.

Approximately 13 percent of the growers reported using non-chemical approaches for controlling diseases. The growers reported using these alternatives on approximately 13 percent of the total acres.

Table 9. Alternative Disease Control Methods, Percentage of Acres Treated with Each Method, Targeted Diseases, and Quality of Control.

Alternative Method	% of Acres Treated	Targeted Diseases with % of Growers Listing the Disease	Quality of Control as % of Growers Responding
Burning of Rice Straw (5 responses)	3.8	Stem Rot - 100.0	Exc. - 80.0, Good - 20.0
Resistant Varieties (3 responses) (1 grower specified the variety Kokuho)	3.7	Stem Rot - 66.7; Unknown - 33.3	**Stem Rot:** Fair - 50.0, Poor - 50.0 **Unknown:** Good
Cultural Practices (Not Specified) (1 response)	3.0	Stem Rot	Excellent
Rotation (1 response)	1.5	Stem Rot	Good
Flooding (1 response)	0.6	Stem Rot	Unknown
Straw Incorporation (1 response)	0.5	Stem Rot	Poor

INSECT CONTROL

Table 10. Acres Reported as Being Infested with Various Insects

Insect	As Percentage of Total Rice Acres
Tadpole Shrimp	18.8
Rice Water Weevil	17.4
Crayfish	9.0
Rice Leaf Miner	3.4
Rice Seed Midge	2.9
Armyworm	2.9
Western Yellowstriped Armyworm	0.7

Table 11. Insects Listed as Causing the Greatest Money Loss.

Insect	Percentage of Growers Listing the Insect
Rice Water Weevil	29.6
Tadpole Shrimp	16.0
Crayfish	1.2

Note: Approximately 52% of the growers indicated that no insect caused a "great" economic loss to their rice crop.

Acres Treated With Insecticides: 15,990 (40.6% of total acres)

Table 12. Insecticides Used, Percentage of Acres Treated, Average Number of Applications, Average Rate, Targeted Insects, and Estimated Quality of Control.

Insecticide	% of Total Acres Treated	Avg. # of Applic.	Avg. Rate/A	Targeted Insect(s) with % of Growers Listing the Insect	Quality of Control as % of Growers Responding
Furadan 5G (48 responses)	34.5	1	9.8 lb	Rice Water Weevil - 100.0	Exc. - 43.8, Good - 45.8, Fair - 6.3, Poor - 2.1, Unknown - 2.1
Copper Sulfate (28 responses)	14.2	1	10.2 lb	Tadpole Shrimp - 100.0	Exc. - 57.1, Good - 28.6, Fair - 3.6, Unknown - 7.1
Methyl Parathion (11 responses)	10.8	1	0.99 pt	Tadpole Shrimp - 72.7; Rice Seed Midge - 36.4	**Tadpole Shrimp:** Exc.-50.0, Good-37.5, Unknown-12.5 **Rice Seed Midge:** Exc.-50.0, Good-50.0

Table 13. Insecticide Costs, and Methods of Application

Insecticide	Avg. Chemical Cost/Acre for Each Application	Avg. Application Cost/Acre for Each Application	Method of Application
Furadan 5G	$7.95	$3.33	Aerial - 58.3%, Ground - 29.2%, Unknown - 12.5%
Copper Sulfate	$5.41	$3.62	Aerial - 81.3%, Unknown - 18.8%
Methyl Parathion	$3.81	$3.18	Aerial - 81.8%, Unknown - 18.2%

Approximately 11 percent of the growers reported using alternatives to insecticides for controlling insects. The growers reported using these alternatives on approximately 12 percent of the total acres.

Table 14. Alternative Insect Control Methods, Percentage of Acres Treated with Each Method, Targeted Insects, and Quality of Control.

Alternative Method	% of Acres Treated	Targeted Insects with % of Growers Listing the Insect	Quality of Control as % of Growers Responding
Cultural Practices (not specified) (2 responses)	5.7	Rice Water Weevil - 50.0; Tadpole Shrimp - 50.0	**Rice Water Weevil**: Exc. **Tadpole Shrimp**: Exc.
Drain Field (3 responses)	2.8	Tadpole Shrimp - 100.0	Exc. - 33.3, Good - 66.7
Clean field borders/levees (3 responses)	2.2	Rice Water Weevil - 100.0	Good - 33.3, Fair - 33.3, Unknown - 33.3
Rotation (1 response)	1.5	Rice Water Weevil	Good

Approximately 84 percent of the growers reported attending a pesticide applicator training session in the past four years. They rated the session as follows:

Excellent - 19.7%
Good - 62.0%
Fair - 14.1%
Poor - 2.8%
Unknown - 1.4%

When asked if they changed any of their pesticide practices as a result of attending the session, approximately 37 percent responded "yes". The changes listed and the percentage of growers listing each change are as follows:

Wear more protective gear - 40.0%
Read labels more closely - 30.0%
More careful in general - 30.0%
Using less material with better timing - 5.0%
Pesticide handling all done by air (commercial applicator) - 5.0%

Growers were asked to indicate which precautions or protective gear they used when handling pesticides. The responses and the percentage of growers listing each response are as follows:

Goggles - 65.5%
Rubber gloves - 72.6%
Rubber boots - 46.4%
Long sleeve shirt - 67.9%
Tractor with cab - 22.6%

Growers were asked where they obtained most of their information about the proper use of pesticides. The responses and the percentage of growers listing each response are as follows:

Pesticide dealer - 78.6%
County agent - 29.8%
Commercial consultant - 11.9%
Farm magazine - 3.6%
Neighbor - 3.6%
Other - 6.0%

Finally, growers were asked where they would prefer to obtain new information about pesticides. The responses and the percentage of growers listing each response are as follows:

Fact sheets - 57.1%
Magazines - 10.7%
Meetings - 44.1%
Newspapers - 2.4%
Radio - 2.4%
Television - 2.4%
Update letters - 53.6%

COMMENTS FROM RICE GROWERS

- Without the use of herbicides and pesticides it would not be economical to grow rice in the State of California.

- In California rice production we can't have just one herbicide to use year after year. We need new chemical tools to fight weeds that are genetically changing to stay alive. Crop rotation works, but is too expensive since no other crop will produce consistent income.

- Something is needed to control river bulrush after planting. Roundup was sprayed around boxes to control weeds then birds controlled crawfish. Lost stand on about 5 acres because we could not keep it flooded after Ordram application.

- If Ordram is taken away from California due to pesticide levels in the river, rice yields would drop 50 cwt/acre.

- If it works (Londax, Ordram 8E, and ethyl parathion) don't try and fix it!

- I farm in an area of high potential for rice water weevil damage. In 1988, 1990, 1991 I've lost an average of 200 acres per year. Salvaged by replanting. If I lose Furadan 5G for protection, my rice farming days will end in financial disaster. I max lbs/acre every field every year and still have major problems.

- We like to control weeds on levees and roads. We feel this helps over time to curtail the weed population. It would be a big asset to legally use non-crop chemicals on the levees, especially with machine application.

- All of my rice acres were treated with insecticides by the county mosquito abatement program.

- Weeds did not cause a money loss because I used chemicals.

- Over the past 4 years we have had problems with rice water weevil. We applied Furadan 5G on borders only for three years, and each year had weevil go beyond the barrier. This year we applied Furadan 5G solid and had no problem. Didn't see any dead ducks. If we lose Furadan it will definitely affect our production.

- We need to get together and figure out the burning of the straw. It will become a big problem in the future to come!

- California rice industry relies on fewer chemicals than any other growing area in the world but grass and sedge and broadleaf herbicides are essential. We are being punished by our herbicide and pesticide rules and regulations. Causing higher costs, limiting herbicides available (excessive California registration cost and handling regulations which serve no purpose or positive result in use). Regulatory effort is purely to sustain funding the bureaucracy. Progress is "reduced reported use" because of excessive cost and bureaucracy in use. End result is making California farmers less competitive in world market. Thai rice farmers still use DDT ($.50/acre)!!! Southern and Australian farmers tank mix most chemicals and make 3 applications of Lorsban. A tank mix of Ordram or Bolero plus Londax is not allowed in California - Big Disadvantage. These herbicide are compatible and would give better control (timing often poor due to weather, custom applicators) and reduce costs 50%.

- Proper use of agricultural chemicals are so important to good crops. We need to do all that is necessary to continue their use.

- The line between "control" and economic disaster is getting increasingly thin as the cost for chemicals increases and selection and potency decreases. My '93 costs were 60% for chemicals/40% for fertilizers. No pests, weeds or diseases were eradicated but merely "controlled" with, fortunately in '93, minimal economic loss. <u>Un</u>economical agriculture is <u>un</u>sustainable agriculture with a corresponding disaster to the environment as proven by the USSR and a long list of other third world countries. The U.S. has achieved the most abundant highest quality and most economical food supply (with least harm to the environment) of any nation in history. The Extension Services "real world" science and research was, and is, the <u>key</u> to this success. To not recognize these simple facts is suicidal for American agriculture <u>and</u> the environment. Note: The weed and insect infested acres are listed (*in this survey*), but pests are being controlled with pesticides.

- This field was in the Artois area of Glenn County. It is a relatively new area for rice which fortunately has no insect or disease problems. It is not typical of most rice fields in Glenn County.

- There was a secondary benefit of draining fields for stand establishment i.e., tadpole shrimp control.

Table 15. California Acres Treated and Total Pounds Per Acre by Pesticide Active Ingredient

Common Name	Total Acres Treated - Survey	% of Total Acres	Total Acres Treated - California	Rate/Acre (lbs ai)	Total Pounds of Active Ingredient - California
2,4-D	1,844	4.7	20,680	0.475	9,823
bensulfuron	32,859	83.4	366,960	0.05	19,036
carbofuran	13,569	34.5	151,800	0.49	74,382
copper sulfate	11,353*	28.8	126,720	10.9	1,381,248
MCPA	4,471	11.4	50,160	0.6	30,096
methyl parathion	4,246	10.8	47,520	0.495	23,522
molinate	31,139	79.1	348,040	3.76	1,309,583
propanil	285	0.7	3,080	4.0	12,320
thiobencarb	7,154	18.2	80,080	3.8	304,364

* Includes uses as a fungicide and an insecticide.

RESULTS OF 1993 LOUISIANA RICE GROWER PESTICIDE USE SURVEY

Number of Growers Surveyed: 254

Number of Growers Responding: 76 (30% response rate)

Total Rice Acres Reported: 21,841

Water Seeded Acres: 78%
Dry Broadcast: 16%
Drill Seeded: 7%

Soil Types: Silt Loam - 40%; Clay - 31%; Sandy Loam - 27%; Clay/Sand - 3%

Average Yield Per Acre: 27.7 Barrels (56 responses) and 98.9 Bushels (14 responses)

Table 1. Reported Varieties

Variety	Percentage of Total Acres
Mars	18.9
Maybelle	16.6
Lemont	12.1
Cypress	11.5
Rico	11.2
Orion	8.2
Jackson	5.3
Lacassine	3.5
Rice Tec	2.4
RT 7015	2.1
Tebonnet	2.0
Bengal	1.8
Newbonnet	1.6
Saturn	1.2
Gulfmont	0.7
Alan	0.3
Toro II	0.2
Delmont	0.2

Table 2. Acres Reported as Being Infested with Various Weeds.

Weed	As Percentage of Total Rice Acres	Weed	As Percentage of Total Rice Acres
Barnyardgrass (Watergrass)	48.5	Yellow Nutsedge	7.7
Hemp Sesbania (Coffeebean)	31.8	Mannagrass	5.9
Northern Jointvetch (Curly Indigo)	25.9	Broadleaf Signalgrass	4.3
Alligatorweed	23.9	Dayflower	2.1
Red Rice	22.2	Pickerelweed	1.1
Ducksalad	18.5	Water Berry	0.8
Ammannia (Redstem)	9.0	Sprangletop	0.6
Texasweed (Mexicanweed)	8.9	Black Rice	0.1
Sedges (Annual)	8.7		

Table 3. Weeds Listed as Causing the Greatest Money Loss

Weed	As Percentage of Growers Listing the Weed	Weed	As Percentage of Growers Listing the Weed
Barnyardgrass (Watergrass)	28.8	Hemp Sesbania (Coffeebean)	2.7
Red Rice	23.3	Sprangletop	2.7
Alligatorweed	11.0	Ammannia (Redstem)	1.4
Ducksalad	9.6	Pickerelweed	1.4
Northern jointvetch (Curly Indigo)	8.2	Foxtail	1.4
Nutsedge	4.1	Gooseweed	1.4
Texasweed (Mexicanweed)	4.1	Grass (Not specified)	1.4
Water Bermuda	4.1		

Note: Approximately 10 percent of the growers indicated that no weed caused a "great" economic loss to their rice crop.

Acres Treated with Herbicides: 17,979 (82.3% of total acres).

Table 4. Herbicides Used, Percentage of Acres Treated, Average Number of Applications, Average Rate, Targeted Weeds, and Estimated Quality of Control.

Herbicide	% of Total Acres Treated	Avg. # of Applic.	Avg. Rate/A	Targeted Weed(s) with % of Growers Listing the Weed	Quality of Control as % of Growers Responding
2,4-D amine (27 responses)	42.6	1.0	1.9 pt	Northern jointvetch - 51.9; Alligatorweed - 33.3; Hemp sesbania - 29.6; Ducksalad - 11.1	**Northern jointvetch:** Exc.-28.6, Good-42.9, Fair-11.1, Unknown-7.1 **Alligatorweed:** Exc.-22.2, Good-55.6, Fair-22.2 **Hemp Sesbania:** Exc.-62.5, Good-12.5, Fair-12.5, Poor **Ducksalad:** Exc.-40.0, Good-60.0
Propanil (27 responses)	36.8	1.04	3.5 qt	Annual Grass*-74.1; All weeds-11.1; Hemp sesbania-14.8; Morningglory-3.7; Northern jointvetch-3.7; Redstem-3.7; Spikerush-3.7; Unknown-14.8	**Annual Grass:** Exc.-20.0, Good-50.0, Fair-25.0, Poor-5.0 **All weeds:** Good-33.3, Fair-66.7 **Hemp sesbania:** Exc.-25.0, Good-75.0 **Morningglory:** Fair **Northern jointvetch:** Exc. **Redstem:** Unknown **Spikerush:** Good **Unknown:** Good-50.0, Fair-25.0, Unknown-25.0
Molinate (Ordram 15G & 8E) (25 responses)	32.3	1.0	24.2 lb 4.0 qt	Barnyardgrass-60.0; All weeds-4.0; Grass-4.0; Red rice-4.0; Water bermuda-8.0; Yellow nutsedge-12.0; Unknown-12.0	**Barnyardgrass:** Exc.-26.7, Good-40.0, Fair-20.0, Unknown-13.3 **All weeds:** Exc. **Unknown:** Good-33.3, Unknown-66.7 **Grass:** Good **Red rice:** Exc. **Water bermuda:** Poor-100.0 **Yellow nutsedge:** Exc.-66.7, Good-33.3
Arrosolo (propanil + molinate) (25 responses)	21.0	1.0	2.94 qt	Barnyardgrass-64.0; Hemp sesbania-12%; Broadleaf signalgrass-8.0; Grass-8%; Northern jointvetch-8.0; Redstem-4.0; Sedges-4.0; Unknown-4.0	**Barnyardgrass:** Exc.-43.8, Good-25.0, Fair-25.0, Unknown-6.3 **Hemp sesbania:** Exc.-100.0 **Broadleaf signalgrass:** Exc.-50.0, Good-50.0 **Grass:** Exc.-100.0 **Northern jointvetch:** Exc.-50.0, Good-50.0 **Redstem:** Fair **Sedges:** Good **Unknown:** Exc.-50.0, Good-50.0
Londax (25 responses)	20.4	1.0	1.78 oz	Ducksalad-32.0; Nutsedge-24.0; Alligatorweed-16.0; Redstem-12.0; Aquatics-4.0; Dayflower-4.0; Hemp sesbania-4.0; Mexicanweed-4.0; Northern jointvetch-4.0; Pickerelweed-4.0; Unknown-4.0	**Ducksalad:** Exc.-12.5, Good-37.5, Fair-12.5, Poor-25, Unknown-12.5 **Nutsedge:** Exc.-66.7, Good-16.7, Fair-16.7 **Alligatorweed:** Exc.-75.0, Good-25.0 **Redstem:** Good-66.7, Unknown-33.3 **Aquatics:** Good **Dayflower:** Good **Hemp sesbania:** Good **Mexicanweed:** Good **Northern jointvetch:** Fair **Pickerelweed:** Good **Unknown:** Good
Grandstand (15 responses)	10.2	1.0	1.2 pt	Alligatorweed-73.3; Ducksalad-13.3; Mexicanweed-13.3; Broadleaf signalgrass-6.7; Broadleaves-6.7; Northern jointvetch-6.7; Hemp sesbania-6.7; Morningglory-6.7	**Alligatorweed:** Exc.-27.3, Good-45.5, Poor-9.1, Unknown-18.2 **Ducksalad:** Good-100.0 **Mexicanweed:** Good **Broadleaf signalgrass:** Good **Broadleaves:** Exc. **Northern jointvetch:** Exc. **Hemp sesbania:** Good **Morningglory:** Good

Roundup (6 responses)	8.2	1.0	1.74 pt	Mannagrass-50.0; All weeds-33.3; Grass-16.7	**Mannagrass:** Good-100.0 **All weeds:** Good-100.0 **Grass:** Exc.
Facet (9 responses)	6.5	1.0	0.73 lb	Barnyardgrass-66.7; Alligatorweed-11.1; Morningglory-11.1; Northern jointvetch-11.1; Grass-11.1; All weeds-11.1	**Barnyardgrass:** Exc.-33.3, Good-66.7 **Alligatorweed:** Poor **Morningglory:** Good **Northern jointvetch:** Good **Grass:** Good **All weeds:** Fair
Basagran (6 responses)	2.7	1.0	1.7 pt	All weeds-16.7; Cocklebur-16.7; Ducksalad-16.7; Nutsedge-16.7; Spikerush-16.7; Unknown-16.7	**All weeds:** Poor **Cocklebur:** Good **Ducksalad:** Exc. **Nutsedge:** Good **Spikerush:** Good **Unknown:** Exc.
2,4-D Dacamine (5 responses)	2.3	1.0	1.95 pt	Northern jointvetch-66.7; Alligatorweed-33.3; Hemp sesbania-16.7; Birdeye(?)-16.7; Broadleaves-16.7; Unknown-16.7	**Northern jointvetch:** Good-100.0 **Alligatorweed:** Good-100.0 **Hemp sesbania:** Good **Birdeye:** Good **Broadleaves:** Good **Unknown:** Exc.
Bolero 8E (3 responses)	2.1	1.0	6.5 pt	Barnyardgrass-66.7; Foxtail-33.3; Grass-33.3	**Barnyardgrass:** Good-50.0, Fair-50.0 **Foxtail:** Good **Grass:** Unknown
Prowl (2 responses)	1.3	1.0	1.8 qt	Barnyardgrass-50.0; Grass-50.0	**Barnyardgrass:** Exc. **Grass:** Good
Gramoxone (2 responses)	1.3	1.0	1.0 qt	All weeds (burndown)-100.0	**All weeds:** Exc.-100.0
Blazer (3 responses)	1.1	1.5	1.0 pt (1 grower)	Hemp sesbania-66.7; Morningglory-33.3; Unknown-33.3	**Hemp sesbania:** Exc.-50.0, Good-50.0 **Morningglory:** Good **Unknown:** Unknown
Whip (1 response)	0.2	1.0	Unknown	Grass	**Grass:** Good

Table 5. Herbicide Costs, and Methods of Application

Herbicide	Avg. Chemical Cost/A for Each Application	Avg. Application Cost/Acre for Each Application	Method of Application
2,4-D amine	$ 5.36	$4.63	Aerial - 100.0%
Propanil	$14.07	$4.60	Aerial - 100.0%
Ordram 15G	$22.95	$3.68	Aerial - 92.9%, Unknown - 7.1%
Arrosolo (propanil + molinate)	$20.49	$4.26	Aerial - 95.0%, Ground - 5.0%
Londax	$17.62	$3.95	Aerial - 93.8%, Ground - 6.3%
Grandstand	$ 6.41	$4.23	Aerial - 90.9%, Ground - 9.1%
Roundup	$14.75	$4.00	Aerial - 50.0%, Ground - 50.0%
Facet (1 response)	$21.00	Unknown	Ground
Basagran	$11.17	$3.30	Aerial - 83.3%, Ground - 16.7%
2,4-D Dacamine (1 response)	$10.00	$5.00	Ground
Bolero 8E	$10.00	$4.13	Aerial - 100.0
Prowl (1 response)	$ 4.00	$3.75	Aerial
Gramoxone	$ 4.58	$3.50	Aerial - 100.0%
Blazer	$ 5.25	$2.70	Aerial - 100.0%
Whip	No information	No information	No information

Approximately 17 percent of the growers reported using alternatives to herbicides for controlling weeds. The growers reported using these alternatives on approximately 14 percent of the total acres. Note: There must have been some confusion with the question because virtually all rice acres are grown using flood water as a non-chemical weed control method. In addition, the responding Louisiana rice growers indicated that 78 percent of their rice acreage was water seeded which helps reduce the weed pressure from a number of weeds.

Table 6. Alternative Weed Control Methods, Percentage of Acres Treated with Each Method, Targeted Weeds, and Quality of Control.

Alternative Method	% of Acres Treated	Targeted Weeds with % of Growers Listing the Weed	Quality of Control as % of Growers Responding
Cultural practices (not named) (2 responses)	2.8	All weeds - 50.0; Red Rice - 50.0; Alligatorweed - 50.0	Good - 100.0
Pinpoint flood (5 responses)	3.3	Red Rice - 60.0; Grass - 80.0; Broadleaves - 20.0	Exc. - 40.0; Fair - 40.0; Poor - 20.0
Hand weeding (3 responses)	3.2	Red Rice - 100.0; Northern jointvetch - 66.7; Hemp sesbania - 66.7	Exc. - 66.7; Fair - 33.3
Water (not specified) (1 response)	2.9	All weeds	Fair

DISEASE CONTROL

Thirty-one percent of the growers reported using seed treatments. The acres planted with treated seed equaled 21.2% of the total acres surveyed.

Table 7. Seed Treatments by Active Ingredient

Seed Treatment	As Percentage of Acres Planted with Treated Seed
mancozeb	37.9
carboxin	29.9
thiram	23.8
metalaxyl	8.4

Table 8. Acres Reported as Being Affected/Infected by Various Diseases.

Disease	As Percentage of Total Rice Acres
Sheath Blight	28.4
Water Molds	14.1
Blast	11.8
Brown Leaf Spot	3.7
Straighthead	2.6
Stem Rot	1.9
Narrow Brown Leaf Spot	1.7

Table 9. Diseases Listed as Causing the Greatest Money Loss.

Disease	Percentage of Growers Listing the Disease
Sheath Blight	36.9
Blast	21.9
Water Molds	12.3
Straighthead	10.9
Brown Leaf Spot	1.4
Narrow Brown Leaf Spot	1.4

Note: Approximately 22% of the growers indicated that no disease caused a "great" economic loss to their rice crop.

Acres Treated With Fungicides: 7668 (35.1% of total acres)

Table 10. Fungicides Used, Percentage of Acres Treated, Average Number of Applications, Average Rate, Targeted Diseases, and Estimated Quality of Control.

Fungicide	% of Total Acres Treated	Avg. # of Applic.	Avg. Rate/A	Targeted Disease(s) with % of Growers Listing the Disease	Quality of Control as % of Growers Responding
Benlate (23 responses)	22.5	1.05	1.1 lb	Sheath blight - 60.9; Blast - 43.5; Stem Rot - 4.3; Unknown - 4.3	**Sheath blight:** Exc.-7.1, Good-28.6, Fair-57.1, Poor-7.1 **Blast:** Exc.-40.0, Good-40.0, Fair-10.0, Poor-10.0 **Stem Rot:** Fair
Tilt (9 responses)	6.0	1.3	7.2 oz	Sheath blight - 100.0; Blast - 11.1	**Sheath blight:** Exc.-22.2, Good-33.3, Fair-44.4 **Blast:** Exc.
Rovral WP (2 responses)	1.5	1.0	1.0 lb	Sheath blight - 100.0	Good - 50.0, Fair - 50.0
Rovral 4F (3 responses)	1.1	1.0	1.0 pt	Sheath blight - 100.0	Good - 33.3, Fair - 66.7

Table 11. Fungicide Costs, and Methods of Application.

Fungicide	Avg. Chemical Cost/A for Each Application	Avg. Application Cost/Acre for Each Application	Method of Application
Benlate	$14.10	$4.47	Aerial - 100%
Tilt	$22.80	$4.15	Aerial - 100%
Rovral 4F	$20.50	$4.75	Aerial - 100%
Rovral WP	Not Given	Not Given	Aerial

Twelve percent of the growers reported using alternatives to fungicides for controlling diseases. The growers reported using these alternatives on approximately 13 percent of the total acres.

Table 12. Alternative Disease Control Methods, Percentage of Acres Treated with Each Method, Targeted Diseases, and Quality of Control.

Alternative Method	% of Acres Treated	Targeted Diseases with % of Growers Listing the Disease	Quality of Control as % of Growers Responding
Resistant Varieties (10 responses)	9.3	Sheath blight - 70.0; Blast - 50.0; Unknown - 30.0	**Sheath blight:** Good-14.3, Fair-57.1, Poor-28.6 **Blast:** Fair-60.0, Poor-40.0
Cultural Practices (Not Specified) (4 responses)	3.9	Sheath blight - 50.0; Blast - 25.0; Unknown - 50.0	**Sheath blight:** Fair-25.0, Poor-25.0, Unknown - 50.0 **Blast:** Poor **Unknown:** Unknown-100.0

INSECT CONTROL

Table 13. Acres Reported as Being Infested with Various Insects

Insect	As Percentage of Total Rice Acres
Rice Water Weevil	39.5
Rice Stinkbug	28.2
Grasshopper	5.8
Rice Leaf Miner	1.4
Southern Green Stinkbug	0.6
Armyworm	0.05

Table 14. Insects Listed as Causing the Greatest Money Loss.

Insect	Percentage of Growers Listing the Insect
Rice Water Weevil	39.1
Stinkbug	29.7
Grasshopper	4.7
Rice Leaf Miner	1.6

Note: Approximately 25% of the growers indicated that no insect caused a "great" economic loss to their rice crop.

Acres Treated With Insecticides: 10,169 (46.6% of total acres)

Table 15. Insecticides Used, Percentage of Acres Treated, Average Number of Applications, Average Rate, Targeted Insects, and Estimated Quality of Control.

Insecticide	% of Total Acres Treated	Avg. # of Applic.	Avg. Rate/A	Targeted Insect(s) with % of Growers Listing the Insect	Quality of Control as % of Growers Responding
Furadan (26 responses)	29.4	1	16.6 lb	Rice Water Weevil - 100.0	Exc. - 41.7, Good - 37.5, Fair - 12.5, Poor - 4.2
Methyl Parathion (14 responses)	17.2	1.7*	12.1 oz	Stinkbug - 92.9; Grasshopper - 14.3; Rice Leaf Miner - 7.1	**Stinkbug:** Exc.-16.7, Good-75.0, Fair-87.3 **Grasshopper:** Good-50.0, Fair-50.0 **Rice Leaf Miner:** Good

* Includes one grower who indicated 10 applications of methyl parathion were made to one field. The other responding growers made 1-2 applications.

Table 16. Insecticide Costs, and Methods of Application

Insecticide	Avg. Chemical Cost/A for Each Application	Avg. Application Cost/Acre for Each Application	Method of Application
Furadan	$12.42	$4.34	Aerial - 100.0
Methyl Parathion	$ 5.11	$4.00	Aerial - 90.0, Unknown - 10.0

Approximately 12 percent of the growers reported using alternatives to insecticides for controlling insects. The growers reported using these alternatives on approximately 4 percent of the total acres.

Table 17. Alternative Insect Control Methods, Percentage of Acres Treated with Each Method, Targeted Insects, and Quality of Control.

Alternative Method	% of Acres Treated	Targeted Insects with % of Growers Listing the Insect	Quality of Control as % of Growers Responding
Drain field (9 responses)	3.9	Rice Water Weevil - 100.0	Exc. - 11.1, Good - 55.6, Fair - 33.3

Approximately 91 percent of the growers reported attending a pesticide applicator training session in the past four years. They rated the session as follows:

Excellent - 37.7%
Good - 43.5%
Fair - 13.0%
Poor - 4.3%

When asked if they changed any of their pesticide practices as a result of attending the session, approximately 52 percent responded "yes". The changes listed and the percentage of growers listing each change are as follows:

Wear more protective gear - 50.0%
Read labels more closely - 43.3%
More careful in general - 30.0%
More careful calibration - 10.0%
Ground applications instead of aerial - 3.3%

Growers were asked to indicate which precautions or protective gear they used when handling pesticides. The responses and the percentage of growers listing each response are as follows:

Goggles - 42.1%
Rubber gloves - 65.8%
Rubber boots - 34.2%
Long sleeve shirt - 57.9%
Tractor with cab - 35.5%

Growers were asked where they obtained most of their information about the proper use of pesticides. The responses and the percentage of growers listing each response are as follows:

Pesticide dealer - 71.1%
County agent - 44.7%
Commercial consultant - 23.7%
Farm magazine - 14.5%
Neighbor - 10.5%
Other - 5.3%

Finally, growers were asked where they would prefer to obtain new information about pesticides. The responses and the percentage of growers listing each response are as follows:

Fact sheets - 55.3%
Magazines - 18.4%
Meetings - 34.2%
Newspapers - 2.6%
Radio - 1.3%
Television - 3.9%
Update letters - 68.4%

COMMENTS FROM RICE GROWERS

- Workers, full time or part time, should not have to comply *(with regulations required by EPA)* as long as a certified private pesticide applicator (farmer) is present during the operation, such as flagging, mixing, cleaning equipment.

- I have become environmentally aware of pesticides, however, in SW Louisiana it is very difficult to grow crops without them, almost impossible. I try not to use pesticides until absolutely necessary. I would challenge any environmentalist on the safety of U.S. grown food.

- I rotate crawfish with rice. As a result of not using pesticides my yield probably suffers. However, I believe it is the safest thing to do, to protect my crawfish yields and not subject the public to any edible products such as crawfish that has been exposed to these pesticides.

- I don't handle chemicals at all. They are sent to a flying service and they do the handling.

- Furadan must be saved from the list of doomed agricultural chemicals. It is vital to the future of our industry. Also, a less expensive control for sheath blight must be found.

- We need a better control for sheath blight and water mold.

- Farmers or farm agencies should be consulted to try and accomplish what is needed for worker protection to have sensible rules and procedures that can be economically possible.

- I would like to see Furadan continued in the future in rice. This is the only chemical left to treat water weevil.

Table 18. Louisiana Acres Treated and Total Pounds Per Acre by Pesticide Active Ingredient

Common Name	Total Acres Treated - Survey	% of Total Acres	Total Acres Treated - Louisiana	Rate/Acre (lbs ai)	Total Pounds of Active Ingredient - Louisiana
2,4-D	9,313	42.6	232,170	0.95	232,784
acifluorfen	280	1.3	7,085	1.5	10,521
benomyl	4,909	22.5	122,625	0.55	67,444
bensulfuron	4,456	20.4	111,180	0.067	7,435
bentazon	590	2.7	14,715	0.85	12,508
carbofuran	6,416	29.4	160,230	0.5	79,795
glyphosate	1,785	8.2	44,690	1.03 D-PAK	46,031
iprodione	564	2.6	14,170	0.5	7,085
methyl parathion	3,753	17.2	93,470	0.38	35,434
molinate	11,629	53.3	290,485	3.4	989,590
paraquat	286	1.3	7,085	0.63	4,428
pendimethalin	280	1.3	7,085	1.5	10,521
propanil	12,624	57.8	315,010	3.03	954,895
propiconazole	1,315	6.0	32,700	0.20	6,622
quinclorac	1,414	6.5	35,425	0.37	12,930
thiobencarb	450	2.1	11,445	6.5	74,393
triclopyr	2,221	10.2	55,590	0.45	25,016

RESULTS OF 1993 TEXAS
RICE GROWER PESTICIDE USE SURVEY

Number of Growers Surveyed: 1300

Number of Growers Responding: 197 (15% response rate)

Total Rice Acres Reported: 48,291

Drill Seeded Acres: 56%
Dry Broadcast Acres: 29%
Water Seeded Acres: 15%

Soil Types: Sandy Loam - 50%; Clay - 36%; Silt Loam - 14%;

Average Yield Per Acre: 68.4 cwt/A

Table 1. Reported Varieties

Variety	Percentage of Total Acres
Gulfmont	40.9
Lemont	29.5
Maybelle	14.4
Jackson	2.9
Cypress	2.0
Jasmine	1.9
Tebonnet	1.2
Labelle	1.1
Katy	1.1
Rico	0.6
Newbonnet	0.5
Bengal	0.2
Orion	0.1
RT 7015	0.01

Table 2. Acres Reported as Being Infested with Various Weeds.

Weed	As Percentage of Total Rice Acres	Weed	As Percentage of Total Rice Acres
Barnyardgrass	57.6	Johnsongrass	2.1
Dayflower	36.1	Smartweed	1.5
Broadleaf Signalgrass	32.6	Mexican Sprangletop	1.5
Yellow Nutsedge	27.1	Eclipta	1.4
Sprangletop	18.1	Wiregrass	1.2
Hemp Sesbania	15.7	Ammannia (Redstem)	1.1
Red Rice	12.4	Gooseweed	1.0
Crabgrass (Common)	11.8	Red Sprangletop	0.9
Bearded Sprangletop	11.5	Northern Jointvetch	0.9
Sedge	10.4	Water Hyssop	0.6
Morningglory	10.1	Water Primrose	0.6
Alligatorweed	9.8	Hoorahagrass	0.4
Ducksalad	8.6	Spearhead	0.3
Mexicanweed	8.6	Arrowhead	0.2
Flatsedge	5.8	Water Plantain	0.2
Texas Panicum	4.1	Cocklebur	0.1
Texasweed	4.1	Smallflower Umbrellaplant	0.1
Spikerush	3.9	Fimbristylis	0.06
Redweed	3.8	Fall Panicum	0.04
Crabgrass (Large)	2.8		

Table 3. Weeds Listed as Causing the Greatest Money Loss

Weed	Percentage of Growers Listing the Weed
Barnyardgrass	30.1
Red Rice	14.0
Sprangletop	11.0
Broadleaf Signalgrass	6.6
Dayflower	4.4
Red Top	3.7
Hemp Sesbania	3.7
Sedge	2.9
Yellow Nutsedge	2.9
Morningglory	2.9
Purple Nutsedge	2.2
Mexicanweed	1.5
Redweed	1.5
Spikerush	1.5
Alligatorweed	0.7
Northern Jointvetch	0.7
Flatsedge	0.7
Hoorahagrass	0.7
Johnsongrass	0.7
Redstem	0.7

Note: Approximately 13 percent of the growers indicated that no weed caused a "great" economic loss to their rice crop.

Acres Treated with Herbicides: 46,811 (96.9% of total acres).

Table 4. Herbicides Used, Percentage of Acres Treated, Average Number of Applications, Average Rate, Targeted Weeds, and Estimated Quality of Control.

Herbicide	% of Total Acres Treated	Avg. # of Applic.	Avg. Rate/A	Targeted Weed(s) with % of Growers Listing the Weed	Quality of Control as % of Growers Responding
Stam M-4 (85 responses)	54.0	1.2	2.9 qt	Barnyardgrass - 62.4; Broadleaf Signalgrass - 32.9; Dayflower - 11.8; Unknown - 11.8; Sprangletop - 10.6; Broadleaves - 15.4	**Barnyardgrass:** Exc.-26.4, Good-43.4, Fair-18.9, Poor-1.9, Unknown-9.4 **Broadleaf Signalgrass:** Exc.-35.7, Good-32.1, Fair-25.0, Poor-7.1 **Dayflower:** Exc.-50.0, Good-40.0, Fair-10.0 **Unknown:** Exc.-10.0, Good-60.0, Unknown-30.0 **Sprangletop:** Exc.-22.2, Good-33.3, Fair-44.4 **Broadleaves:** Exc.-30.8, Good-46.2, Fair-15.4, Unknown-7.7
Arrosolo 3-3E (70 responses)	42.5	1.2	3.8 qt	Barnyardgrass - 52.9; Dayflower - 20.0; Broadleaf Signalgrass - 14.3; Sprangletop - 14.3; Unknown - 14.3; All weeds - 10.0; Redweed - 8.6; Nutgrass - 8.6; Mexicanweed - 7.1; Other - 9.9	**Barnyardgrass:** Exc.-16.2, Good-56.8, Fair-21.6, Unknown-5.4 **Dayflower:** Exc.-28.6, Good-50.0, Fair-14.3, Unknown-7.1 **Broadleaf signalgrass:** Exc.-20.0, Good-50.0, Fair-20.0, Unknown-10.0 **Sprangletop:** Exc.-30.0, Good-40.0, Fair-30.0 **Unknown:** Exc.-10.0, Good-30.0, Fair-10.0, Unknown-50.0 **All Weeds:** Exc.-28.6, Good-57.1, Fair-14.3 **Redweed:** Exc.-50.0, Good-50.0 **Nutgrass:** Exc.-33.3, Good-50.0, Fair-16.7 **Mexicanweed:** Exc.-20.0, Good-80.0
Bolero 8E (78 responses)	51.5	1.1	2.5 pt	Barnyardgrass - 39.7; Sprangletop - 42.3; Dayflower - 19.2; Unknown - 12.8; Red Top - 9.0; Broadleaf Signalgrass - 7.7; All weeds - 5.1; Crabgrass - 5.1; Other - 12.9	**Barnyardgrass:** Exc.-28.1, Good-37.5, Fair-25.0, Unknown-9.4 **Sprangletop:** Exc.-26.5, Good-55.9, Fair-8.8, Poor-2.9, Unknown-5.9 **Dayflower:** Exc.-31.3, Good-50.0, Fair-12.5, Poor-6.3 **Unknown:** Exc.-10.0, Good-20.0, Unknown-70.0 **Redtop:** Exc.-28.6, Good-42.9, Fair-14.3, Unknown-14.3 **Broadleaf Signalgrass:** Exc.-33.3, Good-33.3, Fair-33.3 **All weeds:** Exc.-50.0, Good-50.0 **Crabgrass:** Exc.-25.0, Good-50.0, Fair-25.0
Basagran 4E (47 responses)	26.1	1.1	1.1 pt	Yellow Nutsedge (Sedge) - 53.2; Dayflower - 48.9; Alligatorweed - 8.5; Unknown - 8.5; Hemp Sesbania - 6.4; Morningglory - 6.4; Sprangletop - 6.4; Other - 25.5	**Yellow Nutsedge (sedge):** Exc.-20.0, Good-48.0, Fair-16.0, Unknown-16.0 **Dayflower:** Exc.-39.1, Good-43.5, Fair-8.7, Unknown-8.7 **Alligatorweed:** Exc.-25.0, Good-25.0, Fair-25.0, Unknown-25.0 **Unknown:** Exc.-25.0, Good-50.0, Unknown-25.0 **Hemp Sesbania:** Exc.-66.7, Fair-33.3 **Morningglory:** Good-66.7, Fair-33.3, **Sprangletop:** Exc.-33.3, Good-66.7

Facet (48 responses)	20.3	1.0	0.65 lb	Barnyardgrass - 64.6; Broadleaf Signalgrass - 31.3; Redweed - 16.7; Unknown - 16.7; Crabgrass - 8.3; Sprangletop - 8.3; Other - 16.7	**Barnyardgrass:** Exc.-64.5, Good-32.3, Fair-3.2, **Broadleaf signalgrass:** Exc.-66.7, Good-33.3 **Redweed:** Exc.-62.5, Good-25.0, Fair-12.5 **Unknown:** Exc.-12.5, Good-37.5, Fair-12.5, Poor-12.5, Unknown-25.0 **Crabgrass:** Exc.-75.0, Fair-25.0 **Sprangletop:** Exc.-50.0, Good-50.0
Ordram 8E (24 responses)	9.3	1.1	2.1 pt	Barnyardgrass - 41.7; Unknown - 20.8; Broadleaf Signalgrass - 16.7; All weeds - 8.3; Dayflower - 8.3; Red Rice - 8.3; Other - 12.6	**Barnyardgrass:** Exc.-60.0, Good-30.0, Fair-10.0 **Unknown:** Good-40.0, Poor-20.0, Unknown-40.0 **Broadleaf Signalgrass:** Exc.-25.0, Good-50.0, Fair-25.0 **All weeds:** Good-50.0, Fair-50.0 **Dayflower:** Exc.-100.0 **Red Rice:** Exc.-50.0, Good-50.0
Ordram 15G (23 responses)	7.7	1.0	23.0 lb	Barnyardgrass - 43.5; Sprangletop - 26.1; Unknown - 13.0; Broadleaf Signalgrass - 13.0; Purple Nutsedge - 8.7; Red Top - 8.7; Other - 12.9	**Barnyardgrass:** Exc.-10.0, Good-40.0, Fair-40.0, Poor-10.0 **Sprangletop:** Exc.-16.7, Good-33.3, Fair-33.3, Unknown-16.7 **Unknown:** Exc.-33.3, Good-66.7 **Broadleaf Signalgrass:** Good-33.3, Fair-33.3, Poor-33.3 **Purple Nutsedge:** Fair-100.0 **Red Top:** Exc.-50.0, Good-50.0
2,4-D (11 responses)	7.5	1.0	1.8 pt	Alligatorweed - 36.4; Dayflower - 36.4; Morningglory - 18.2; Mexicanweed - 18.2; All weeds - 9.1; Ducksalad - 9.1; Spikerush - 9.1; Flatsedge - 9.1; Sedge - 9.1; Unknown - 9.1	**Alligatorweed:** Exc.-75.0, Unknown-25.0 **Dayflower:** Exc.-50.0, Good-50.0 **Morningglory:** Exc.-100.0 **Mexicanweed:** Exc.-50.0, Unknown-50.0 **All weeds:** Exc. **Ducksalad:** Exc. **Spikerush:** Unknown **Flatsedge:** Exc. **Sedge:** Unknown **Unknown:** Unknown
Prowl 4E (6 responses)	5.0	1.0	1.1 qt	Barnyardgrass - 33.3; Sprangletop - 33.3; Crabgrass - 16.7; Dayflower - 16.7; Unknown - 16.7	**Barnyardgrass:** Good-50.0, Fair-50.0 **Sprangletop:** Good-50.0, Fair-50.0 **Crabgrass:** Good **Dayflower:** Unknown **Unknown:** Fair
Stam 80 EDF (12 responses)	4.8	1.0	3.3 lb	Barnyardgrass - 33.3; Unknown - 33.3; All weeds - 16.7; Dayflower - 16.7; Grasses - 16.7; Hemp Sesbania - 8.3; Broadleaves - 8.3; Red Top - 8.3; Sprangletop - 8.3	**Barnyardgrass:** Exc.-100.0 **Unknown:** Good-66.7, Unknown-33.3 **All weeds:** Exc.-50.0, Good-50.0 **Dayflower:** Exc.-100.0 **Grasses:** Good-100.0 **Hemp Sesbania:** Exc. **Broadleaves:** Good **Red Top:** Exc. **Sprangletop:** Exc.
Londax (9 responses)	3.9	1.0	1.0 oz	Nutsedge - 66.7; Redstem - 22.2; Barnyardgrass - 22.2; Dayflower - 11.1; Texasweed - 11.1; Broadleaf Signalgrass - 11.1	**Nutsedge:** Good-50.0, Fair-50.0 **Redstem:** Exc.-50.0, Fair-50.0 **Barnyardgrass:** Fair-100.0 **Dayflower:** Fair **Mexicanweed:** Exc. **Texasweed:** Good **Broadleaf Signalgrass:** Fair

Propanil (formulations other than Stam) (10 responses)	2.3	1.1	3.0 qt	Barnyardgrass - 90.0; Broadleaf Signalgrass - 50.0; Dayflower - 30.0; Crabgrass - 20.0; Texasweed - 20.0; Sprangletop - 20.0; Hemp Sesbania - 10.0	**Barnyardgrass:** Good-66.7, Fair-22.2, Unknown-11.1 **Broadleaf Signalgrass:** Good-60.0, Fair-20.0, Unknown-20.0 **Dayflower:** Good-66.7, Fair-33.3 **Crabgrass:** Good-50.0, Fair-50.0 **Texasweed:** Good-50.0, Unknown-50.0 **Sprangletop:** Good-100.0 **Hemp Sesbania:** Unknown
Grandstand (4 responses)	2.0	1.0	0.75 pt	Alligatorweed - 25.0; Mexicanweed - 25.0; All weeds - 25.0; Unknown - 25.0	**Alligatorweed:** Good **Mexicanweed:** Good **All weeds:** Exc. **Unknown:** Good
Rhomene (MCPA) (6 responses)	1.5	1.0	1.1 pt	Redweed - 33.3; Northern Jointvetch - 33.3; All Broadleaves - 16.7; Mexicanweed - 16.7; Gooseweed - 16.7; Sedge - 16.7; Turtleback(?) - 16.7	**Redweed:** Exc.-50.0, Good-50.0 **Northern Jointvetch:** Exc.-50.0, Good-50.0 **All Broadleaves:** Exc. **Mexicanweed:** Good **Gooseweed:** Exc. **Sedge:** Good **Turtleback:** Good
Whip (7 responses)	0.8	1.0	0.9 pt	Barnyardgrass - 42.9; Unknown - 42.9; Red Top - 14.3; Broadleaf Signalgrass - 14.3	**Barnyardgrass:** Exc.-33.3, Good-33.3, Unknown-33.3 **Unknown:** Good-33.3, Poor-33.3, Unknown-33.3 **Red Top:** Unknown **Broadleaf Signalgrass:** Exc.
Blazer 2L (2 responses)	0.4	1.0	1.0 pt	Hemp Sesbania - 50.0; Pigweed - 50.0; Ironweed - 50.0	**Hemp Sesbania:** Exc. **Pigweed:** Poor **Ironweed:** Poor

Table 5. Herbicide Costs, and Methods of Application

Herbicide	Avg. Chemical Cost/A for Each Application	Avg. Application Cost/Acre for Each Applic.	Method of Application
Stam M-4	$18.60	$4.66	Aerial - 92.5%, Ground - 7.5%
Arrosolo 3-3E	$20.75	$4.53	Aerial - 94.6%, Ground - 3.6%, Unknown - 3.6%
Bolero 8E	$14.88	$4.34	Aerial - 95.9%, Ground - 6.1%
Basagran 4E	$11.33	$4.76	Aerial - 83.8%, Ground - 13.5%, Unknown - 5.4%
Facet	$25.34	$4.49	Aerial - 97.4%, Ground - 5.3%
Ordram 8E	$13.92	$5.26	Aerial - 36.8%, Ground - 10.5% Drip - 52.6%
Ordram 15G	$22.18	$4.24	Aerial - 100.0%,
2,4-D	$ 4.02	$5.20	Aerial - 100.0%
Prowl 4E	$12.45	$5.02	Aerial - 100.0%
Stam 80 EDF	$16.19	$5.79	Aerial - 100.0%
Londax	$16.12	$4.96	Aerial - 100.0%
Propanil (formulations other than Stam)	$17.48	$4.43	Aerial - 88.8% Unknown - 11.1
Grandstand	$ 9.62	$4.29	Aerial - 75.0% Ground - 25.0
Rhomene (MCPA)	$ 5.83	$4.84	Aerial - 100.0%
Whip	$16.34	$4.63	Aerial - 100.0%
Blazer	$ 8.71	$4.50	Aerial - 100.0

Approximately 31 percent of the growers reported using alternatives to herbicides for controlling weeds. The growers reported using these alternatives on approximately 17 percent of the total acres. Note: There must have been some confusion with the question because virtually all rice acres are grown using flood water as a non-chemical weed control method. In addition, the responding Texas rice growers indicated that 15 percent of their rice acreage was water seeded which helps reduce the weed pressure from a number of weeds.

Table 6. Alternative Weed Control Methods, Percentage of Acres Treated with Each Method, Targeted Weeds, and Quality of Control.

Alternative Method	% of Acres Treated	Targeted Weeds with % of Growers Listing the Weed	Quality of Control as % of Growers Responding
Water Management (32 responses)	16.5	Barnyardgrass - 37.5, All weeds - 34.4, Broadleaf Signalgrass - 15.6, Red Rice - 9.4, Dayflower - 6.3, Red Top - 6.3, Unknown - 6.3, Other - 6.2	**Barnyardgrass:** Good-33.3, Fair-50.0. Poor-8.3, Unknown-8.3 **All weeds:** Exc.-9.1. Good-9.1, Fair-63.6, Poor-18.2 **Broadleaf Signalgrass:** Good-60.0, Fair-40.0 **Red Rice:** Exc.-33.3, Good-66.7 **Dayflower:** Exc.-50.0, Good-50.0 **Red Top:** Exc.-50.0, Good-50.0 **Unknown:** Poor-33.3, Unknown-66.7
Tillage (not specified) (1 response)	0.6	All weeds	Poor
Withhold Fertilizer (1 response)	0.2	All weeds	Good

DISEASE CONTROL

Approximately ninety-three percent of the growers reported using seed treatments. The acres planted with treated seed equaled 91.8% of the total acres surveyed.

Table 7. Seed Treatments by Active Ingredient

Seed Treatment	As Percentage of Acres Planted with Treated Seed
carboxin	69.5
gibberellic acid	21.7
zinc	15.5
mancozeb	7.6
captan	1.7
metalaxyl	0.5
PCNB	0.2
thiram	0.2

Table 8. Acres Reported as Being Affected/Infected by Various Diseases.

Disease	As Percentage of Total Rice Acres
Sheath Blight	45.8
Rice Blast	14.9
Narrow Brown Leafspot	9.1
Brown Leafspot	8.3
Black Sheath Rot	4.2
Stem Rot	2.8
Leaf Smut	1.6
Kernel Smut	1.6
Straighthead*	0.4
Leaf Smut	1.7

* Straighthead is a physiological disorder, not a true disease.

Table 9. Diseases Listed as Causing the Greatest Money Loss.

Disease	Percentage of Growers Listing the Disease
Sheath Blight	49.6
Blast	17.6
Narrow Brown Leafspot	4.2
Black Sheath Rot	3.4
Stem Rot	2.5
Brown Leafspot	1.7
Straighthead	1.7
Bacterial Leaf Blight	0.8
Kernel Smut	0.8
Leaf Smut	0.8

Note: Approximately 17% of the growers indicated that no disease caused a "great" economic loss to their rice crop.

Acres Treated With Fungicides: 16,805 (34.8% of total acres)

Table 10. Fungicides Used, Percentage of Acres Treated, Average Number of Applications, Average Rate, Targeted Diseases, and Estimated Quality of Control.

Fungicide	% of Total Acres Treated	Avg. # of Applic.	Avg. Rate/A	Targeted Disease(s) with % of Growers Listing the Disease	Quality of Control as % of Growers Responding
Benlate (31 responses)	20.4	1.2	0.9 lb	Blast - 67.7; Sheath Blight - 54.8; Leaf Spot - 6.5; Kernel Smut - 3.2; Black Sheath Rot - 3.2; Unknown - 6.5	**Blast:** Exc.-9.5, Good-52.4, Fair-14.3, Poor-9.5, Unknown-14.3 **Sheath Blight:** Exc.-11.8, Good-41.2, Fair-29.4, Unknown-17.6 **Leaf Spot:** Good-50.0, Fair-50.0 **Kernel Smut:** Poor **Black Sheath Rot:** Unknown **Unknown:** Good-50.0, Unknown-50.0
Tilt (23 responses)	11.6	1.0	8.8 oz	Sheath blight - 87.0; Unknown - 13.0; Blast - 4.3; Black Sheath rot - 4.3; Stem Rot - 4.3; Kernel Smut - 4.3	**Sheath blight:** Exc.-15.0, Good-50.0, Fair-30.0, Poor-5.0 **Blast:** Exc.-Good **Black Sheath Rot:** Good **Stem Rot:** Good **Kernel Smut:** Fair
Rovral (14 responses)	11.0	1.0	1.2 pts	Sheath blight - 85.7; Blast - 14.3; Unknown - 7.1	**Sheath Blight:** Exc.-8.3, Good-50.0, Fair-41.7 **Blast:** Good-100.0 **Unknown:** Good
TopCop (3 responses)	1.6	1.3	2.0 qt	Blast - 66.7; Kernel Smut - 33.3; Sheath Blight - 33.3; Various - 33.3	**Blast:** Exc.-50.0, Good-50.0, **Kernel Smut:** Good **Sheath Blight:** Exc. **Various:** Fair

Table 11. Fungicide Costs, and Methods of Application.

Fungicide	Avg. Chemical Cost/A for Each Application	Avg. Application Cost/A for Each Application	Method of Application
Benlate	$13.59	$4.28	Aerial - 100%
Tilt	$24.54	$4.53	Aerial - 95%, Unknown - 5%
Rovral 4F	$17.37	$4.33	Aerial - 100%
TopCop	$ 7.83	$4.98	Aerial - 100%

Fourteen percent of the growers reported using alternatives to fungicides for controlling diseases. The growers reported using these alternatives on approximately 15.3 percent of the total acres.

Table 12. Alternative Disease Control Methods, Percentage of Acres Treated with Each Method, Targeted Diseases, and Quality of Control.

Alternative Method	% of Acres Treated	Targeted Diseases with % of Growers Listing the Disease	Quality of Control as % of Growers Responding
Reduced Plant Density (seeding rate, drill spacing) (6 responses)	5.3	Sheath Blight - 100.0; Blast - 16.7; Stem Rot - 16.7	**Sheath Blight:** Good-50.0, Unknown-50.0 **Blast:** Good **Stem Rot:** Good
Resistant Varieties (5 responses)	4.2	Sheath Blight - 60.0; Blast - 20.0; Unknown - 20.0	**Sheath Blight:** Exc.-66.7, Good-33.3 **Blast:** Good **Unknown:** Unknown
Water Management (deep water) (4 responses)	2.1	Sheath Blight - 50.0; Blast - 25.0; Unknown - 50.0	**Sheath Blight:** Poor-50.0, Unknown-50.0 **Blast:** Poor **Unknown:** Exc.-50.0, Fair-50.0
Fertilization (lower N rates, high potash rates) (4 responses)	1.7	Sheath Blight - 75.0; Unknown - 25.0	**Sheath Blight:** Unknown-100.0 **Unknown:** Unknown
Cultural Practices (one response was "summer plowing") (4 responses)	1.0	All Diseases - 50.0; Sheath Blight - 25.0; Unknown - 25.0	**All Diseases:** Exc.-50.0, Poor-50.0 **Sheath Blight:** Fair **Unknown:** Unknown

INSECT CONTROL

Table 13. Acres Reported as Being Infested with Various Insects

Insect	As Percentage of Total Rice Acres
Rice Stinkbug	70.4
Grasshopper	18.2
Rice Water Weevil	16.3
Armyworm	5.5
Rice Stalk Borer	1.8
Sugarcane Borer	1.7
Chinchbug	1.5
Fall armyworm	1.0
Rice Seed Midge	1.0
Leafhopper	0.8
Mexican Rice Borer	0.3
Rice Skipper	0.1

Table 14. Insects Listed as Causing the Greatest Money Loss

Insect	Percentage of Growers Listing the Insect	Insect	Percentage of Growers Listing the Insect
Rice Stinkbug	56.8	Chinchbug	2.7
Rice Water Weevil	9.0	Mexican Rice Borer	0.9
Armyworm	7.2	Rice Seed Midge	0.9
Grasshopper	4.5		

Note: Approximately 18% of the growers indicated that no insect caused a "great" economic loss to their rice crop.

Acres Treated With Insecticides: 29,959 (62% of total acres)

Table 15. Insecticides Used, Percentage of Acres Treated, Average Number of Applications, Average Rate, Targeted Insects, and Estimated Quality of Control.

Insecticide	% of Total Acres Treated	Avg. # of Applic.	Avg. Rate/A	Targeted Insect(s) with % of Growers Listing the Insect	Quality of Control as % of Growers Responding
Methyl Parathion (70 responses)	57.7	2.0	0.93 pt	Rice Stinkbug - 87.1; Grasshopper - 18.6; Armyworm - 8.6; Sugarcane Borer - 5.7; Chinchbug - 5.7; Unknown - 4.3; Mexican Rice Borer - 2.8; Leafhopper - 1.4	**Rice Stinkbug:** Exc.- 36.1, Good-57.4, Fair-3.3, Unknown-3.3 **Grasshopper:** Exc.-30.8, Good-53.8, Fair-7.7, Unknown-7.7 **Armyworm:** Exc.-66.7, Good-33.3 **Sugarcane Borer:** Exc.-75.0, Good-25.0 **Chinchbug:** Good-25.0, Fair-50.0, Unknown-25.0 **Unknown:** Good-66.7, Unknown-33.3 **Mexican Rice Borer:** Exc. **Leafhopper:** Good
Furadan 3G (9 responses)	6.9	1.0	17.1 lbs	Rice Water Weevil - 88.9; Unknown - 11.1	**Rice Water Weevil:** Exc.-33.3, Good-44.4, Fair-11.1, Unknown-11.1 **Unknown:** Unknown
Sevin XLR Plus (13 responses)	6.9	1.2	1.0 qt	Rice Stinkbug - 84.6; Grasshopper - 30.8; Chinchbug - 15.4; Unknown - 7.7	**Rice Stinkbug:** Exc.-45.0, Good-36.4, Fair-9.1, Unknown-9.1 **Grasshopper:** Exc.-25.0, Good-25.0, Fair-25.0, Unknown-25.0 **Unknown:** Unknown
Penncap-M 2E (3 responses)	1.9	1.0	1.0 pt	Rice Stinkbug - 100.0; Grasshopper - 66.7	**Rice Stinkbug:** Exc.-33.3, Good-66.7 **Grasshopper:** Good-100.0
Sevin 50WP (2 responses)	1.5	2.5	1.0 lb	Chinchbug - 50.0; Rice Stinkbug - 50.0	**Chinchbug:** Exc. **Rice Stinkbug:** Good
Karate (3 responses)	1.2	1.0	3.0 oz	Armyworm - 100.0	Exc.-100.0
Sevin 80S (1 response)	1.0	1.0	1.25 lb	Rice Stinkbug	Good
Furadan 5G (2 responses)	0.7	1.0	16 lb	Rice Water Weevil - 100.0	Good-50.0, Unknown-50.0
Malathion 5E (1 response)	0.7	2.0	1.0 pt	Rice Stinkbug	Exc.
Sevin 4F (1 response)	0.2	2.0	1.0 qt	Rice Stinkbug	Good

Table 16. Insecticide Costs, and Methods of Application

Insecticide	Avg. Chemical Cost/A for Each Applic.	Avg. Application Cost/Acre for Each Applic.	Method of Application
Methyl Parathion	$4.62	$3.17	Aerial - 100.0
Furadan 3G	$11.40	$3.61	Aerial - 75.0, Unknown - 25.0
Sevin XLR Plus	$6.60	$3.25	Aerial - 100.0
Penncap-M 2E	$5.67	$3.00	Aerial - 100.0
Sevin 50WP	$4.10	$3.00	Aerial
Karate	$5.50	$3.50	Aerial - 100.0
Sevin 80S	$3.85	$6.00	Aerial
Furadan 5G	$10.00	$3.00	Aerial - 100.0
Malathion 5E	$2.86	$2.50	Aerial
Sevin 4F	NA	NA	Aerial

Approximately 6 percent of the growers reported using alternatives to insecticides for controlling insects. The growers reported using these alternatives on approximately 5 percent of the total acres.

Table 17. Alternative Insect Control Methods, Percentage of Acres Treated with Each Method, Targeted Insects, and Quality of Control.

Alternative Method	% of Acres Treated	Targeted Insects with % of Growers Listing the Insect	Quality of Control as % of Growers Responding
Water Management (Drying Field) (4 responses)	3.7	Rice Water Weevil - 100.0	Good-75.0, Fair-25.0
Cultural Practices (2 responses)	1.0	Rice Water Weevil - 50.0; All Insects - 50.0	**Rice Water Weevil:** Good **All Insects:** Poor
Dipel (1 response)	0.2	Armyworm	Poor

Approximately 81 percent of the growers reported attending a pesticide applicator training session in the past four years. They rated the session as follows:

Excellent - 21.6%
Good - 62.1%
Fair - 12.9%
Poor - 4.3%

When asked if they changed any of their pesticide practices as a result of attending the session, approximately 47 percent responded "yes". The changes listed and the percentage of growers listing each change are as follows:

Wear more protective gear - 36.4%
Read labels more closely - 38.2%
More careful in general - 12.7%
Observed pest thresholds before spraying - 12.7
More careful calibration - 9.1%
Clean & dispose of containers more carefully - 5.5
Watch weather conditions closely - 3.6
Stress safety to employees - 1.8
Recordkeeping - 1.8

Growers were asked to indicate which precautions or protective gear they used when handling pesticides. The responses and the percentage of growers listing each response are as follows:

Goggles - 24.3%
Rubber gloves - 54.2%
Rubber boots - 36.8%
Long sleeve shirt - 54.9%
Tractor with cab - 26.4%

Growers were asked where they obtained most of their information about the proper use of pesticides. The responses and the percentage of growers listing each response are as follows:

Pesticide dealer - 61.1%
County agent - 31.9%
Commercial consultant - 16.7%
Farm magazine - 9.0%
Neighbor - 8.3%
Other - 16.0%

Finally, growers were asked where they would prefer to obtain new information about pesticides. The responses and the percentage of growers listing each response are as follows:

Fact sheets - 63.2%
Magazines - 15.3%
Meetings - 46.5%
Newspapers - 4.2%
Radio - 2.1%
Television - 1.4%
Update letters - 54.2%

Table 18. Texas Acres Treated and Total Pounds Per Acre by Pesticide Active Ingredient

Common Name	Total Acres Treated - Survey	% of Total Acres	Total Acres Treated - Texas	Rate/Acre (lbs ai)	Total Pounds of Active Ingredient - Texas
2,4-D	3,615	7.5	22,500	0.9	20,250
acifluorfen	210	0.8	2,400	0.26	312
benomyl	9,866	20.4	61,200	0.45	27,540
bensulfuron	1,904	3.9	11,700	0.038	439
bentazon	12,622	26.1	78,300	0.55	43,064
carbaryl	4,625	9.6	28,800	0.92	26,550
carbofuran	3,673	7.6	22,800	0.54	12,299
copper sulfate	792	1.6	4,800	???	???
cyhalothrin	578	1.2	3,600	0.023	84
fenoxaprop	407	0.8	2,400	0.11	270
iprodione	5,289	11.0	33,000	0.6	19,800
malathion	317	0.7	2,100	0.63	1,313
MCPA	746	1.5	4,500	0.55	2,475
methyl parathion	27,840	57.7	173,100	0.47	80,492
molinate	28,744	59.5	178,500	2.8	501,660
pendimethalin	2,429	5.0	15,000	1.1	16,500
propanil	50,042	103.7	311,100	2.87	893,223
propiconazole	5,615	11.6	34,800	0.25	8,630
quinclorac	9,790	20.3	60,900	0.33	19,793
thiobencarb	24,895	51.5	154,500	2.5	386,250
triclopyr	960	2.0	6,000	0.28	1,680

APPENDIX C.

Sample Rice Specialist/Researcher Survey

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE
RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: ARKANSAS - RICE WEED CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Arkansas, Mississippi, Texas, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice weed control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER:

TITLE:

ADDRESS:

PHONE #:

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of weed problems of rice obtained from the 1992 grower survey of pesticide use on rice in Arkansas. Growers were asked to list the weed(s) that caused the greatest money loss in their 1992 rice crop. The weeds are ranked according to the number of growers listing the weed with the most listed weed ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state in 1992 is an accurate representation of the weed problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the spaces provided. Rank only the weeds that cause economic damage starting with the worst weed as ranking number 1.

Table 1. Ranking of economically important rice weed problems.

Weed	Ranking*	New Ranking (if applicable)
Barnyardgrass	1	
Red Rice	2	
Morningglory	3	
Hemp Sesbania	4	
Sprangletop	5	
Northern Jointvetch	6	
Yellow Nutsedge	7	
Redstem	7	
Ducksalad	8	
Smartweed	9	
Broadleaf Signalgrass	9	
OTHER WEEDS? (Please list and rank if possible)		

* #1 equals most damaging weed of 1993 Arkansas rice crop. #2 equals next most damaging weed of 1993 Arkansas rice crop, etc.

2. IMPACT OF HERBICIDE CANCELLATIONS - In order to determine the benefits of herbicides to rice production, we are asking three basic questions concerning the loss of herbicides on rice. First, what will be the impact of the loss of individual herbicides on rice production? Second, what will be the impact of the loss of groups of related herbicides on rice production? And finally, what will be the impact of the loss of all herbicides on rice production?

Part I. LOSS OF INDIVIDUAL ACTIVE INGREDIENTS - In this part we address the impact of the loss of individual herbicides. Your responses should be based upon the use of currently registered herbicides for weed infestations in an average year.

A. LOST HERBICIDES - The herbicides reported as being used on the 1992 rice crop are listed in the first column of Table 2. Please list any omitted herbicides. Trade names for the listed common names are on page 10.

B. ALTERNATIVE CONTROLS - To the right of each herbicide listed in column 1, list the alternatives that would be used in your state in place of that herbicide should it be withdrawn from use. These alternatives may be other herbicides or non-pesticide controls. **After each alternative listed place a slash (/), then a percentage figure which is your best estimate of how much of the acreage currently treated by the "lost" herbicide would be treated with the alternative.** Example: If the lost herbicide was propanil and the alternatives would be thiobencarb and water seeding, then the entry might appear as: thiobencarb/30; water seeding/65. This indicates that 30% of the acreage currently treated with propanil would be treated with thiobencarb, 65% would be managed with water seeding, and that 5% would not be treated.

C. YIELD IMPACT - Estimate the percentage yield change on the acreage currently treated with the herbicide in column 1 should that herbicide be removed. Identify increases with a (+) and decreases with a (-).

1. ALTERNATIVES USED - First, make an estimate with the assumption that all alternatives mentioned in the previous column will be used as indicated.

2. ALTERNATIVES NOT USED - Next, make an estimate with the assumption that no alternatives will be used.

D. SECONDARY EFFECTS - Make note here of any secondary effects, if any, due to the use of alternatives i.e., development of weed resistance, increased cost of control, reduction in quality of rice, weeds not controlled, etc.

Table 2. Impact of the Loss of Individual Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide	Alternatives Used if Herbicide is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide is Lost and Alternatives are:		Secondary Effects***
		Used	Not Used	
propanil				
2,4-D				
molinate				
thiobencarb				
quinclorac				
pendimethalin				
bromoxynil				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of weed resistance, increase of cost control, weeds not controlled, etc.

FURTHER COMMENTS FROM TABLE 2. CONCERNING:

ALTERNATIVES:

YIELD IMPACTS:

SECONDARY EFFECTS:

Part II. LOSS OF GROUPS OF RELATED HERBICIDES - This section deals with the impact of the loss of groups/families of related herbicides listed in Table 3. The information needed to fill out Table 3 is very similar to that required for Table 2. Again, your responses should be based upon the use of currently registered herbicides for weed infestations in an average year.

A. HERBICIDE GROUPS - Listed below are groups of herbicides that could be removed simultaneously from use. The groups are listed in the first column on Table 3. Trade names for the listed common names are on page 10.

GROWTH REGULATORS (2,4-D, triclopyr)

CARBAMATES (molinate, thiobencarb)

ALL HERBICIDES

B. ALTERNATIVE CONTROLS - To the right of each herbicide group listed in column 1, list the alternatives that would be used in your state in place of that herbicide group should it be withdrawn from use. These alternatives may be other herbicide groups, individual herbicides, or non-pesticide controls. After each alternative listed place a slash (/), then a percentage figure which is your best estimate of how much of the acreage currently treated by the "lost" herbicide group would be treated with the alternative.

C. YIELD IMPACT - Estimate the percentage yield change on the acreage currently treated with the herbicide group in column 1 should that herbicide be removed. Identify increases with a (+) and decreases with a (-).

1. ALTERNATIVE USED - First, make an estimate with the assumption that all alternatives mentioned in the previous column will be used as indicated.

2. ALTERNATIVES NOT USED - Next, make an estimate with the assumption that no alternatives will be used.

D. SECONDARY EFFECTS - Make note here of any secondary effects, if any, due to the use of alternatives i.e., development of weed resistance, increased cost of control, reduction in quality of rice, weeds not controlled, etc.

Table 3. Impact of the Loss of Groups of Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide Group is Lost and Alternatives are:		Secondary Effects***
		Used	Not Used	
Growth Regulators (2,4-D, triclopyr)				
Carbamates (molinate, thiobencarb)				
ALL HERBICIDES				
OTHER HERBICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide group that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.

*** Secondary effects due to alternatives i.e., development of weed resistance, increase cost of control, weeds not controlled, etc.

FURTHER COMMENTS FROM TABLE 3. CONCERNING:

ALTERNATIVES:

YIELD IMPACTS:

SECONDARY EFFECTS:

TRADE NAMES OF COMMONLY USED RICE HERBICIDES IN ARKANSAS

COMMON NAME	TRADE NAME(S)
acifluorfen	Blazer
bensulfuron	Londax
bentazon	Basagran
bromoxynil	Buctril
2,4-D	Weedar 64, Dacamine and various other formulations
fenoxaprop	Whip
glyphosate	Roundup
molinate	Ordram, Arrosolo
pendimethalin	Prowl
propanil	Stam, Wham, Arrosolo and other formulations
quinclorac	Facet
thiobencarb	Bolero
triclopyr	Grandstand

APPENDIX D.

Rice Specialist/Researcher Survey Results

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: ARKANSAS - RICE WEED CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Arkansas, Mississippi, Texas, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice weed control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Ford L. Baldwin

TITLE: Extension Weed Specialist

ADDRESS: P.O. Box 391

Little Rock, AR 72203

PHONE #: 501-671-2223

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of weed problems of rice obtained from the 1992 grower survey of pesticide use on rice in Arkansas. Growers were asked to list the weed(s) that caused the greatest money loss in their 1992 rice crop. The weeds are ranked according to the number of growers listing the weed with the most listed weed ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state in 1992 is an accurate representation of the weed problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the spaces provided. Rank only the weeds that cause economic damage starting with the worst weed as ranking number 1.

Table 1. Ranking of economically important rice weed problems.

Weed	Ranking*	New Ranking (if applicable)
Barnyardgrass	1	1
Red Rice	2	2
Morningglory	3	3
Hemp Sesbania	4	4
Sprangletop	5	5
Northern Jointvetch	6	6
Yellow Nutsedge	7	9
Redstem	7	7
Ducksalad	8	8
Smartweed	9	9
Broadleaf Signalgrass	9	7
OTHER WEEDS? (Please list and rank if possible)		

* #1 equals most damaging weed of 1993 Arkansas rice crop. #2 equals next most damaging weed of 1993 Arkansas rice crop, etc.

Specialist's Note: In Table 1 I would probably switch yellow nutsedge and broadleaf signalgrass. Yellow nutsedge is increasing and is difficult/expensive to control. However, as a percent of acres treated or needing treatment it is still well behind the others. Broadleaf signalgrass is rapidly increasing. Many fields now have as much broadleaf signalgrass as barnyardgrass - the farmers must call it all barnyardgrass.

Table 2. Impact of the Loss of Individual Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide	Alternatives Used if Herbicide is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
propanil	quinclorac/50%, molinate/50%, thiobencarb/50%, fenoxaprop/50%, pendimethalin/50%[1]	(-)20 if alt. is quinclorac, (-)40 if alt. are molinate or pendimethalin, (-)50 if alt. is fenoxaprop, (-)30 if alt. is thiobencarb	(-)80	Increased cost and increased herbicide use. Narrow spectrum - all of the alternatives are used in tank mix or combinations with propanil.
2,4-D	triclopyr/75%, propanil/25%, acifluorfen/25%	0 if alt. is triclopyr, (-)10 if alt. are propanil or acifluorfen	(-)10	The big economic impact will not be yield loss but quality discounts from "black" seeds.
molinate	propanil, quinclorac, thiobencarb, pendimethalin	(-)10	0 to (-)40	Molinate is the only salvage herbicide for big grass. Where a farmer gets good control early - no yield impact if (molinate) lost and alternative is used. However, if it fails early, loss can be 40% or greater.
thiobencarb	propanil, quinclorac, fenoxaprop, pendimethalin	0 if alt. are propanil or pendimethalin, (-)10 if alt. is quinclorac, (-)20 if alt. is fenoxaprop	(-)20	Thiobencarb is the best sprangletop herbicide. Sprangletop is rapidly increasing. Fenoxaprop injures rice.
quinclorac	propanil, molinate, thiobencarb, pendimethalin	0	(-)80	Increased number of applications of different herbicides.

Table 1. Ranking of economically important rice weed problems.

Weed	Ranking*	New Ranking (if applicable)
Barnyardgrass	1	1
Red Rice	2	2
Morningglory	3	3
Hemp Sesbania	4	4
Sprangletop	5	5
Northern Jointvetch	6	6
Yellow Nutsedge	7	9
Redstem	7	7
Ducksalad	8	8
Smartweed	9	9
Broadleaf Signalgrass	9	7
OTHER WEEDS? (Please list and rank if possible)		

* #1 equals most damaging weed of 1993 Arkansas rice crop. #2 equals next most damaging weed of 1993 Arkansas rice crop, etc.

Specialist's Note: In Table 1 I would probably switch yellow nutsedge and broadleaf signalgrass. Yellow nutsedge is increasing and is difficult/expensive to control. However, as a percent of acres treated or needing treatment it is still well behind the others. Broadleaf signalgrass is rapidly increasing. Many fields now have as much broadleaf signalgrass as barnyardgrass - the farmers must call it all barnyardgrass.

Table 2. Impact of the Loss of Individual Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide	Alternatives Used if Herbicide is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
propanil	quinclorac/50%, molinate/50%, thiobencarb/50%, fenoxaprop/50%, pendimethalin/50%[1]	(-)20 if alt. is quinclorac, (-)40 if alt. are molinate or pendimethalin, (-)50 if alt. is fenoxaprop, (-)30 if alt. is thiobencarb	(-)80	Increased cost and increased herbicide use. Narrow spectrum - all of the alternatives are used in tank mix or combinations with propanil.
2,4-D	triclopyr/75%, propanil/25%, acifluorfen/25%	0 if alt. is triclopyr, (-)10 if alt. are propanil or acifluorfen	(-)10	The big economic impact will not be yield loss but quality discounts from "black" seeds.
molinate	propanil, quinclorac, thiobencarb, pendimethalin	(-)10	0 to (-)40	Molinate is the only salvage herbicide for big grass. Where a farmer gets good control early - no yield impact if (molinate) lost and alternative is used. However, if it fails early, loss can be 40% or greater.
thiobencarb	propanil, quinclorac, fenoxaprop, pendimethalin	0 if alt. are propanil or pendimethalin, (-)10 if alt. is quinclorac, (-)20 if alt. is fenoxaprop	(-)20	Thiobencarb is the best sprangletop herbicide. Sprangletop is rapidly increasing. Fenoxaprop injures rice.
quinclorac	propanil, molinate, thiobencarb, pendimethalin	0	(-)80	Increased number of applications of different herbicides.

pendimethalin	propanil, quinclorac, molinate, thiobencarb	0	(-)80	Increased costs.
bromoxynil				
triclopyr				
acifluorfen				
fenoxaprop				
bentazon				
glyphosate				
bensulfuron				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of weed resistance, increase of cost control, weeds not controlled, etc.

[1] Percentages are greater than 100 because more than one herbicide will usually be required as an alternative (Specialist's note).

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE
RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: ARKANSAS - RICE WEED CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Arkansas, Mississippi, Texas, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice weed control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Charles B. Guy, Jr

TITLE: Extension Weed Scientist and Research Assistant Professor

ADDRESS: Southeast Research and Extension Center, P.O. Box 3508

Monticello, AR 71656

PHONE #: 501-460-1091

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of weed problems of rice obtained from the 1992 grower survey of pesticide use on rice in Arkansas. Growers were asked to list the weed(s) that caused the greatest money loss in their 1992 rice crop. The weeds are ranked according to the number of growers listing the weed with the most listed weed ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state in 1992 is an accurate representation of the weed problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the spaces provided. Rank only the weeds that cause economic damage starting with the worst weed as ranking number 1.

Table 1. Ranking of economically important rice weed problems.

Weed	Ranking*	New Ranking (if applicable)
Barnyardgrass	1	NO CHANGES
Red Rice	2	
Morningglory	3	
Hemp Sesbania	4	
Sprangletop	5	
Northern Jointvetch	6	
Yellow Nutsedge	7	
Redstem	7	
Ducksalad	8	
Smartweed	9	
Broadleaf Signalgrass	9	
OTHER WEEDS? (Please list and rank if possible)		

* #1 equals most damaging weed of 1993 Arkansas rice crop. #2 equals next most damaging weed of 1993 Arkansas rice crop, etc.

Table 2. Impact of the Loss of Individual Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide	Alternatives Used if Herbicide is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
propanil	Other grass herbicides/95%, water management/5%	(-)35	(-)95	Quality loss, reduced harvest efficiency, greater disease and insect pressure.
2,4-D	triclopyr/80%, acifluorfen/10%, hand weeding/1%	(-)5	(-)20	Quality loss far exceeds yield loss.
molinate	fenoxaprop (for barnyardgrass salvage)/30%, propanil (for barnyardgrass salvage)/30%, thiobencarb (water seeded)/5%	(-)15	(-)20	No other effective salvage treatment (as compared to molinate) for barnyardgrass.
thiobencarb	bensulfuron/30%, pendimethalin/30%, molinate (water seeded)/5%	(-)15	(-)20	
quinclorac	propanil/60%, molinate/10%, thiobencarb/10%, pendimethalin/5%, triclopyr/5%, acifluorfen/5%	(-)10	(-)15	
pendimethalin	thiobencarb/95%	(-)10	(-)15	
bromoxynil				
triclopyr	2,4-D/40%, acifluorfen/10%, quinclorac/10%, bensulfuron/10%	(-)10	(-)15	Quality loss far exceeds yield losses.

acifluorfen	2,4-D/20%, triclopyr/30%, propanil/15%, bensulfuron/30%	(-)10	(-)15	Quality loss far exceeds yield losses.
fenoxaprop	propanil/5%, molinate/5%, thiobencarb//5%, pendimethalin/5%	(-)2 to (-)5	(-)5 to (-)10	
bentazon	triclopyr/20%, bensulfuron/40%	(-)2	(-)5	
glyphosate				
bensulfuron	quinclorac/10%, triclopyr/40%, acifluorfen/20%, thiobencarb/20%	(-)2	(-)5	
OTHER HERBICIDES? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of weed resistance, increase of cost control, weeds not controlled, etc.

FURTHER COMMENTS FROM TABLE 2. CONCERNING:

ALTERNATIVES:

YIELD IMPACTS: (Yield impacts) are all assumed if all other herbicides listed are available. If list is shortened numbers would change dramatically.

SECONDARY EFFECTS:

Table 3. Impact of the Loss of Groups of Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
Growth Regulators (2,4-D, triclopyr)	bensulfuron/60%, quinclorac/10%, acifluorfen/5%, hand weeding/2%	(-)5	(-)20	Quality loss far exceeds yield loss.
Carbamates (molinate, thiobencarb)	propanil/60%, quinclorac/20%, pendimethalin/10%, fenoxaprop/2%	(-)5	(-)30	
ALL HERBICIDES	Quit farming/100%	(-)100	(-)100	
OTHER HERBICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide group that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.

*** Secondary effects due to alternatives i.e., development of weed resistance, increase cost of control, weeds not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: ARKANSAS - RICE WEED CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Arkansas, Mississippi, Texas, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice weed control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Nathan A. Slaton

TITLE: Area Rice Specialist

ADDRESS: Southeast Research and Extension Center, P.O. Box 351

Stuttgart, AR 72160

PHONE #: 501-673-2661

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of weed problems of rice obtained from the 1992 grower survey of pesticide use on rice in Arkansas. Growers were asked to list the weed(s) that caused the greatest money loss in their 1992 rice crop. The weeds are ranked according to the number of growers listing the weed with the most listed weed ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state in 1992 is an accurate representation of the weed problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the spaces provided. Rank only the weeds that cause economic damage starting with the worst weed as ranking number 1.

Table 1. Ranking of economically important rice weed problems.

Weed	Ranking*	New Ranking (if applicable)
Barnyardgrass	1	1
Red Rice	2	1
Morningglory	3	2
Hemp Sesbania	4	4
Sprangletop	5	3
Northern Jointvetch	6	5
Yellow Nutsedge	7	7
Redstem	7	9
Ducksalad	8	8
Smartweed	9	10
Broadleaf Signalgrass	9	6
OTHER WEEDS? (Please list and rank if possible)		

* #1 equals most damaging weed of 1993 Arkansas rice crop. #2 equals next most damaging weed of 1993 Arkansas rice crop, etc.

Table 2. Impact of the Loss of Individual Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide	Alternatives Used if Herbicide is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
propanil	molinate/50%, thiobencarb/20%, quinclorac/50%, triclopyr/20%, 2,4-D/20%, acifluorfen/10%, pendimethalin/10%	(-)10 to (-)25	(-)50 to (-)75	Cultural methods would help but would not be very effective - additional herbicides would be needed to control grass and broadleaf weeds.
2,4-D	triclopyr/75%, acifluorfen/25%, propanil/50%, quinclorac/50%	(-)5	(-)20 to (-)30	Quality loss and some grain yield loss.
molinate	propanil/25%, thiobencarb/25%, quinclorac/25%, pendimethalin/25%	(-)5 to (-)10	(-)50 to (-)75	
thiobencarb	pendimethalin/50%, quinclorac/25%, propanil/50%, molinate/25%	(-)5 to (-)10	(-)50 to (-)75	(Thiobencarb is) best control option for sprangletop. Would also increase broadleaf herbicide use.
quinclorac	propanil/25%, molinate/50%, thiobencarb/50%, pendimethalin/25%	(-)5 to (-)10	(-)50 to (-)75	
pendimethalin	propanil/25%, molinate/25%, thiobencarb/25%, quinclorac/25%	(-)5	(-)50 to (-)75	(One of the) best control options for sprangletop.
bromoxynil				
triclopyr	2,4-D/20%	0	(-)5	

acifluorfen	propanil/20%, 2,4-D/10%, triclopyr/10%	0	(-)5	
fenoxaprop	thiobencarb/10%, pendimethalin/10%	0	(-)30	
bentazon	propanil/10%, triclopyr/10%	0	0	
glyphosate				
bensulfuron	thiobencarb/10%, propanil/10%, 2,4-D/10%	0	(-)10 to (-)20	
OTHER HERBICIDES? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of weed resistance, increase of cost control, weeds not controlled, etc.

FURTHER COMMENTS FROM TABLE 2. CONCERNING:

ALTERNATIVES: Cultural management would help for a short time if herbicides were lost but would soon be overwhelmed from weed populations. Herbicide use would certainly increase if one of the major grass herbicides were lost and yields would decline.

YIELD IMPACTS:

SECONDARY EFFECTS:

Table 3. Impact of the Loss of Groups of Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
Growth Regulators (2,4-D, triclopyr)	Other herbicides/20%	0	(-)10	Grain quality is lost not yield. Will increase the use of other herbicides.
Carbamates (molinate, thiobencarb)	Other herbicides/30%	0	(-)20	(The result would be that) Residual herbicides are lost and rescue treatment for large grass will increase herbicide use.
ALL HERBICIDES	Management and cultural practices/90%, taller varieties/100%	(-)50	(-)75	Yield and quality would decline.
OTHER HERBICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide group that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.

*** Secondary effects due to alternatives i.e., development of weed resistance, increase cost of control, weeds not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: CALIFORNIA - RICE WEED CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in California, Arkansas, Texas, Mississippi, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice weed control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: James E. Hill

TITLE: Extension Rice Agronomist

ADDRESS: Department of Agronomy and Range Science, Univ. of California

Davis, CA 95616

PHONE #: 916-752-7323

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of weed problems of rice obtained from the 1993 grower survey of pesticide use on rice in California. Growers were asked to list the weed(s) that caused the greatest money loss in their 1993 rice crop. The weeds are ranked according to the number of growers listing the weed with the most listed weed ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state is an accurate representation of the weed problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the blank column on the right. Rank only the weeds that cause economic damage starting with the worst weed as ranking number 1.

Table 1. Ranking of economically important rice weed problems.

Weed	Ranking*	New Ranking (if applicable)
Watergrass	1	1
Smallflower Umbrellaplant	2	2
Sprangletop	3	4
Ricefield Bulrush	4	2
Barnyardgrass	5	5
Algae	6	6
Arrowhead	6	6
Ammannia (Redstem)	6	6
California Arrowhead	7	7
Bromegrass	7	7
Roughseed Bulrush	7	7
OTHER WEEDS? (Please list and rank if possible)		

* #1 equals most damaging weed of 1993 California rice crop. #2 equals next most damaging weed of 1993 California rice crop, etc.

Specialist's Note: There is no bromegrass in rice. It's the same as ricefield bulrush. Ricefield bulrush is *Scirpus mucronatus*. About 5 years ago the Weed Science Society of America (WSSA) changed this name from roughseed bulrush. Many growers still refer to roughseed rather than ricefield. This may be why sprangletop is ranked ahead of ricefield bulrush - in fact, I would place *S. mucronatus* even with smallflower umbrellaplant at rank #2.

Table 2. Impact of the Loss of Individual Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide	Alternatives Used if Herbicide is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
bensulfuron	MCPA & 2,4-D (or triclopyr if it becomes registered)/100%, dry seeding/10%	(-)10 if alt. is MCPA/2,4-D, (-)30 if alt. is dry seeding[1]	(-)25	Injury due to phenoxys on rice and injury to other crops due to phenoxy drift. Buildup of weeds to cause losses beyond 25% i.e., sedges can be bad but it will take a while in absence of herbicides to build a seed bank.
molinate	thiobencarb/50%, fenoxaprop/25%, deep water	(-)10 if alt. is thiobencarb, (-)15 if alt. is fenoxaprop, (-)20 if alt. is deep water.	(-)50	Thiobencarb has a narrow application window so grasses will escape. Thiobencarb is more injurious to rice and thiobencarb residues in water are more troublesome. (Deep water) will result in progressively increasing seed bank.
thiobencarb	molinate/100%, deep water	(+)10	(-)25	(Deep water) will result in progressively increasing seed bank.
MCPA	bensulfuron/100%	(+)10	(-)10	Alternative will result in rapid buildup of resistant weeds.
copper sulfate	drain fields/10%	(-)5	(-)5	Important for algae control but algae problems are less serious and widespread than the most important weeds.
2,4-D	bensulfuron/100%	(+)10	(-)10	Alternative will result in rapid buildup of resistant weeds.
propanil	molinate or thiobencarb/100%	Can't estimate	Can't estimate	Propanil has very limited use in California.
glyphosate				Glyphosate is used for ease of tillage operation - no or little impact on yield. No conservation tillage program in California because of no drill seeding to speak of.

sethoxydim	Not used.			
OTHER HERBICIDES? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.
** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.
*** Secondary effects due to use of alternatives i.e., development of weed resistance, increased cost of control, weeds not controlled, etc.

[1] This seems strange that an alternative would cause greater losses than if not used. This is because water seeding controls grasses - dry seeding causes increased grass growth and greater losses - this why only 10% of the growers would probably try it (Specialist's note).

Table 3. Impact of the Loss of Groups of Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
Carbamates (molinate, thiobencarb)	fenoxaprop/80%, propanil/10%, deep water/40%	(-)20 if alt. is fenoxaprop, (-)50 if alt. is propanil, (-)50 if alt. is deep water	Out of business 1st year (-)30, 2nd year (-)50 etc. until yield loss is 100%.	In the 1920s California almost went out of business with no herbicide for grass control. (The 50% reduction if propanil is the alternative) is due to the fact that propanil use is highly restricted already - so even though it is an excellent herbicide it couldn't be used on 75-80% of the acreage as an alternative.
Growth Regulators (2,4-D, MCPA)	bensulfuron	(-)20	(-)40	Resistance will build but rice could still be grown if grass herbicides were available.
ALL HERBICIDES	Deep water/80%, drill-seeded rice/20%		Out of business due to grass (lack of) weed control.	The problem is that cultural controls (deep water, etc.) will work until seed bank gets so heavy rice cannot be grown profitably.
OTHER HERBICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of weed resistance, increased cost of control, weeds not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: LOUISIANA - RICE WEED CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Louisiana, Arkansas, Texas, California, and Mississippi will be surveyed as part of this assessment. Because of your expertise in the area of rice weed control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Dearl Sanders

TITLE: Weed Specialist

ADDRESS: 261 Knapp Hall, Louisiana State University

Baton Rouge, LA 70803

PHONE #: 504-388-4070

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of weed problems of rice obtained from the 1993 grower survey of pesticide use on rice in Louisiana. Growers were asked to list the weed(s) that caused the greatest money loss in their 1993 rice crop. The weeds are ranked according to the number of growers listing the weed with the most listed weed ranked as number 1.

    A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state is an accurate representation of the weed problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

    B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the spaces provided. Rank only the weeds that cause economic damage starting with the worst weed as ranking number 1.

Table 1. Ranking of economically important rice weed problems.

Weed	Ranking*	New Ranking (if applicable)
Barnyardgrass	1	NO CHANGES
Redrice	2	
Alligatorweed	3	
Ducksalad	4	
Northern Jointvetch	5	
Nutsedge[1]	6	
Water Bermuda	6	
Hemp Sesbania	7	
Texasweed[2]	7	
Watergrass[2]	8	
Redstem[2]	8	
Mexicanweed[2]	8	
Pickerelweed	8	
Foxtail	8	
Gooseweed	8	
Red Sprangletop	8	
OTHER WEEDS? (Please list and rank if possible)		

* #1 equals most damaging weed of 1993 Louisiana rice crop. #2 equals next most damaging weed of 1993 Louisiana rice crop, etc.

[1] Nutsedge should be replaced by the term "sedges" (Specialist's note)

[2] Texasweed, watergrass, redstem, and mexicanweed are all the same weed (Specialist's note)

Table 2. Impact of the Loss of Individual Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide	Alternatives Used if Herbicide is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
acifluorfen	triclopyr, 2,4-D	0	(-)8 to (-)10	
bensulfuron	bentazon, 2,4-D, triclopyr	0 if alt. is 2,4-D, (-)5 if alt. are bentazon or triclopyr	(-)5 to (10)	
bentazon	bensulfuron, 2,4-D	0	(-)10	
2,4-D Amine	triclopyr, bensulfuron	(-)5	(-)15 to (-)40	
fenoxaprop	propanil, quinclorac	(+)15	(-)15	
glyphosate	NA			
molinate	propanil, quinclorac	(-)5	(-)20 to (-)40	

paraquat	NA			
pendimethalin	NA			
propanil	quinclorac, molinate	(-)10 if alt. is quinclorac, (-)5 if alt. is molinate	(-)30	
quinclorac	propanil, molinate	0	(-)30	
thiobencarb	NA			
triclopyr	2,4-D, bensulfuron	0 if alt. is 2,4-D, (-)15 if alt. is bensulfuron	(-)30	

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of weed resistance, increased cost of control, weeds not controlled, etc.

Table 3. Impact of the Loss of Groups of Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide Group	Alternatives Used if Group is Lost/ % Used*	Yield Impact** in Percent (%) if Herbicide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
Growth Regulators (2,4-D, triclopyr)	bensulfuron, propanil, quinclorac	(-)15 if alt. is propanil, (-)20 if alt. is bensulfuron, (-)30 if alt. is quinclorac	(-)40	
Carbamates (molinate, thiobencarb)	propanil, quinclorac	(-)5 if alt. is quinclorac, (-)10 if alt. is propanil	(-)30	
ALL HERBICIDES	Water management only.	(-)30	(-)60	
OTHER HERBICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide group that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of weed resistance, increased cost of control, weeds not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: TEXAS - RICE WEED CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Texas, Arkansas, Mississippi, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice weed control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Arlen Klosterboer

TITLE: Professor and Extension Agronomist

ADDRESS: Route 7, Box 999

Beaumont, TX

PHONE #: 409-752-2741

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of weed problems of rice obtained from the 1993 grower survey of pesticide use on rice in Texas. Growers were asked to list the weed(s) that caused the greatest money loss in their 1993 rice crop. The weeds are ranked according to the number of growers listing the weed with the most listed weed ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state is an accurate representation of the weed problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the blank column on the right. Rank only the weeds that cause economic damage starting with the worst weed as ranking number 1.

Table 1. Ranking of economically important rice weed problems.

Weed	Ranking*	New Ranking (if applicable)
Barnyardgrass	1	1
Red Rice	2	2
Sprangletop	3	3
Sedges (Yellow Nutsedge, Purple Nutsedge, Flatsedge)	4	4
Broadleaf Signalgrass	5	5
Dayflower	6	6
Red Top	7	7
Hemp Sesbania	7	8
Morningglory	8	9
Mexicanweed	9	7
Redweed	9	9
Spikerush	9	9
Alligatorweed	10	10
Northern Jointvetch	10	10
Hoorahagrass	10	10
Johnsongrass	10	10
Redstem	10	10
OTHER WEEDS? (Please list and rank if possible)		

* #1 equals most damaging weed of 1993 Texas rice crop. #2 equals next most damaging weed of 1993 Texas rice crop, etc.

Specialist's Note: The entry "red top" may correspond to junglerice and the entry "hoorahagrass" may correspond to fan sedge.

Table 2. Impact of the Loss of Individual Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide	Alternatives Used if Herbicide is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
propanil	molinate/10%, 2,4-D/40%, thiobencarb/20%, bentazon/5%, quinclorac/10%, fenoxaprop/10%	(-)5	(-)80	Cost increase.
molinate	quinclorac/30%, 2,4-D/30%, thiobencarb/20%, propanil/15%, fenoxaprop/5%	(-)5	(-)75	Cost increase.
thiobencarb	propanil/30%, quinclorac/30%, 2,4-D/20%, fenoxaprop/10%	(-)10	(-)20	None
bentazon	propanil/20%, 2,4-D/10%, triclopyr/10%, molinate/10%	(-)5	(-)10	None
quinclorac	propanil/30%, thiobencarb/10%, molinate/10%, pendimethalin/10%	0	(-)25	None
2,4-D	propanil/15%, triclopyr/5%, bentazon/2%, acifluorfen/1%	0	(-)60	Cost increase.
pendimethalin	thiobencarb/5%, quinclorac/5%, propanil/	0	(-)65	None

bensulfuron	propanil/20%, bentazon/15%	0	(-)20	Increase in sedges, rushes, and certain broadleaf weeds.
triclopyr	2,4-D/10%	0	(-)5	None
MCPA	2,4-D/5%, triclopyr/5%	0	(-)5	Increase in broadleaf weeds.
fenoxaprop	molinate/5%	0	(-)5	
acifluorfen	triclopyr/5%, 2,4-D/5%	0	(-)5	
OTHER HERBICIDES? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.

*** Secondary effects due to use alternatives i.e., development of weed resistance, increased cost of control, weeds not controlled, etc.

Table 3. Impact of the Loss of Groups of Herbicides on Rice Production and Use of Alternative Controls.

"Lost" Herbicide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Herbicide Group is Lost and Alternatives are:		Secondary Effects***
		Used	Not Used	
Growth Regulators (2,4-D, MCPA, triclopyr)	propanil/5%, molinate/5%	0	(-)5	
Carbamates (molinate, thiobencarb)	quinclorac/30%, pendimethalin/20%, propanil/50%, growth regulators/10%	(-)10	(-)60	
ALL HERBICIDES	Water management	(-)75	(-)90	
OTHER HERBICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" herbicide that would be treated with the alternative. Alternatives may be other herbicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" herbicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of weed resistance, increased cost of control, weeds not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: ARKANSAS - RICE DISEASE CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Arkansas, Mississippi, Texas, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice disease control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Gary L. Cloud

TITLE: Extension Plant Pathologist

ADDRESS: 2201 Brookwood, P.O. Box 391

Little Rock, AR 72203

PHONE #: 501-671-2235

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of disease problems of rice obtained from the 1992 grower survey of pesticide use on rice in Arkansas. Growers were asked to list the disease(s) that caused the greatest money loss in their 1992 rice crop. The diseases are ranked according to the number of growers listing the disease with the most listed disease ranked as number 1.

    A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state in 1992 is an accurate representation of the disease problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

    B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the spaces provided. Rank only the diseases that cause economic damage starting with the worst disease as ranking number 1.

Table 1. Ranking of economically important rice diseases problems.

Disease	Ranking*	New Ranking (if applicable)
Sheath Blight	1	1
Blast	2	2
Straighthead	3	3
Kernel Smut	4	4
Stem Rot	4	4
OTHER DISEASES? (Please list and rank if possible)		
Black Sheath Rot		4

* #1 equals most damaging disease of 1993 Arkansas rice crop. #2 equals the next most damaging pest of 1993 Arkansas rice crop, etc.

Table 2. Impact of the Loss of Individual Fungicides on Rice Production and Use of Alternative Controls.

"Lost" Fungicide	Alternatives Used if Fungicide is Lost/% Used*	Yield Impact** in Percent (%) if Fungicide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
benomyl	propiconazole/20%, iprodione/60%, resistant variety/15-20%	(-)20	(-)30 to (-)40 (depends on blast severity)	Isolates of <u>P. oryzae</u> could develop resistance to specific fungicides if used frequently. Rice resistance will eventually breakdown.
iprodione	benomyl/20%, propiconazole/15%, tolerant varieties/10%	0	(-)25	Cost of control would be increased by 1/3 if benomyl is used.
propiconazole	benomyl/20%, iprodione/1%, tolerant varieties/10%	0	(-)25	Cost of control would be increased by 1/3 if benomyl is used.
OTHER FUNGICIDES? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" fungicide that would be treated with the alternative. Alternatives may be other fungicide or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" fungicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of disease resistance, increase cost of control, diseases not controlled, etc.

Table 3. Impact of the Loss of Groups of Fungicides on Rice Production and Use of Alternative Controls.

"Lost" Fungicide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Fungicide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
ALL FUNGICIDES	Resistant varieties/15%, tolerant varieties/20%, planting date/5%, fertility levels/25%	(-)30	(-)45 to (-)50	Development of new "races" of P. oryzae to resistance in "Katy" (a variety) rice.
OTHER FUNGICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" fungicide group that would be treated with the alternative. Alternatives may be other fungicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" fungicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of disease resistance, increase cost of control, diseases not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: ARKANSAS - RICE DISEASE CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Arkansas, Mississippi, Texas, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice disease control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Fleet N. Lee

TITLE: Plant Pathologist

ADDRESS: Rice Research and Extension Center, P.O. Box 351

Stuttgart, AR 72610

PHONE #: 501-673-2661

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of disease problems of rice obtained from the 1992 grower survey of pesticide use on rice in Arkansas. Growers were asked to list the disease(s) that caused the greatest money loss in their 1992 rice crop. The diseases are ranked according to the number of growers listing the disease with the most listed disease ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state in 1992 is an accurate representation of the disease problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the spaces provided. Rank only the diseases that cause economic damage starting with the worst disease as ranking number 1.

Table 1. Ranking of economically important rice diseases problems.

Disease	Ranking*	New Ranking (if applicable)
Sheath Blight	1	1
Blast	2	2
Straighthead	3	
Kernel Smut	4	3
Stem Rot	4	4
OTHER DISEASES? (Please list and rank if possible)		
Crown Sheath Rot		4
Brown Leaf Spot		5
Grain Discoloration		6

* #1 equals most damaging disease of 1993 Arkansas rice crop. #2 equals the next most damaging pest of 1993 Arkansas rice crop, etc.

Respondents Note: Straighthead is not a true disease but an abiotic disorder. Control is through tolerant varieties and a cultural practice of thoroughly drying the field prior to internode elongation.

Table 2. Impact of the Loss of Individual Fungicides on Rice Production and Use of Alternative Controls.

"Lost" Fungicide	Alternatives Used if Fungicide is Lost/% Used*	Yield Impact** in Percent (%) if Fungicide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
benomyl	Resistant variety/10%	(+)5	(-)20	Greater selection pressure for blast races to overwhelm variety resistance.
iprodione	benomyl/50%, propiconazole/50%	0	(-)15	Increased costs.
propiconazole	benomyl/50%, iprodione/50%	0	(-)15	Increase costs.
carboxin	mancozeb/90%, other/10%	(-)1	(-)5	Increased loss of stand. Increased production costs.
mancozeb	carboxin//90%, other/10%	(-)1	(-)5	Increased loss of stand. Increased production costs.
metalaxyl	carboxin/50%	(-)1	(-)5	Increased loss of stand. Increased production costs.

* Percentage used denotes the percentage of the acreage currently treated by the "lost" fungicide that would be treated with the alternative. Alternatives may be other fungicide or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" fungicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of disease resistance, increase cost of control, diseases not controlled, etc.

FURTHER COMMENTS FROM TABLE 2. CONCERNING:

ALTERNATIVES: Resistant variety options are very limited for the major diseases. Alternative fungicides currently are not available to replace benomyl for blast control. Sheath blight resistant cultivars are not available at this time.

YIELD IMPACTS:

SECONDARY EFFECTS: Rough rice yields would be reduced by loss of control options. The quality of harvested grain would also be reduced.

Table 3. Impact of the Loss of Groups of Fungicides on Rice Production and Use of Alternative Controls.

"Lost" Fungicide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Fungicide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
ALL FUNGICIDES	Resistant cultivar	(-)10	(-)15	Disease control would be reduced with yield and quality losses.
OTHER FUNGICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" fungicide group that would be treated with the alternative. Alternatives may be other fungicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" fungicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of disease resistance, increase cost of control, diseases not controlled, etc.

FURTHER COMMENTS FROM TABLE 3. CONCERNING:

ALTERNATIVES: Alternative options are very limited and in some cases not efficacious. Resistant variety options are very limited.

YIELD IMPACTS: Total rough rice yields will be reduced.

SECONDARY EFFECTS: Quality of the harvested grain will be reduced. Grain will be lightweight with reduced milling yields.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: ARKANSAS - RICE DISEASE CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Arkansas, Mississippi, Texas, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice disease control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Nathan A. Slaton

TITLE: Area Rice Specialist

ADDRESS: Rice Research and Extension Center, P.O. Box 351

Stuttgart, AR 72160

PHONE #:501-673-2661

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of disease problems of rice obtained from the 1992 grower survey of pesticide use on rice in Arkansas. Growers were asked to list the disease(s) that caused the greatest money loss in their 1992 rice crop. The diseases are ranked according to the number of growers listing the disease with the most listed disease ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state in 1992 is an accurate representation of the disease problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the spaces provided. Rank only the diseases that cause economic damage starting with the worst disease as ranking number 1.

Table 1. Ranking of economically important rice diseases problems.

Disease	Ranking*	New Ranking (if applicable)
Sheath Blight	1	1
Blast	2	2
Straighthead	3	3
Kernel Smut	4	4
Stem Rot	4	3
OTHER DISEASES? (Please list and rank if possible)		
Black Sheath Rot		4

* #1 equals most damaging disease of 1993 Arkansas rice crop. #2 equals the next most damaging pest of 1993 Arkansas rice crop, etc.

Table 2. Impact of the Loss of Individual Fungicides on Rice Production and Use of Alternative Controls.

"Lost" Fungicide	Alternatives Used if Fungicide is Lost/% Used*	Yield Impact** in Percent (%) if Fungicide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
benomyl	iprodione/15%, propiconazole/15%, resistant varieties/15%	(-)20 to (-)30	(-)40 to (-)50	No alternative control of blast but cultural/management practices which are inconsistent.
iprodione	benomyl/25%, propiconazole/25%, tolerant varieties/10%	0	(-)15 to (-)20	
propiconazole	benomyl/25%, iprodione/25%, tolerant varieties/10%	0	(-)15 to (-)20	
OTHER FUNGICIDES? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" fungicide that would be treated with the alternative. Alternatives may be other fungicide or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" fungicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of disease resistance, increase cost of control, diseases not controlled, etc.

Table 3. Impact of the Loss of Groups of Fungicides on Rice Production and Use of Alternative Controls.

"Lost" Fungicide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Fungicide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
ALL FUNGICIDES	Resistant varieties/10%, tolerant varieties/10%, fertility/20%, seeding rates	(-)30 to (-)40	(-)40 to (-)50	
OTHER FUNGICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" fungicide group that would be treated with the alternative. Alternatives may be other fungicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" fungicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of disease resistance, increase cost of control, diseases not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: CALIFORNIA - RICE DISEASE CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in California, Arkansas, Texas, Mississippi, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice disease control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Jeff Oster

TITLE: Plant Pathologist

ADDRESS: P.O. Box 306

Biggs, CA

PHONE #: 916-860-5481

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of disease problems of rice obtained from the 1993 grower survey of pesticide use on rice in California. Growers were asked to list the disease(s) that caused the greatest money loss in their 1993 rice crop. The diseases are ranked according to the number of growers listing the disease with the most listed disease ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state is an accurate representation of the disease problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the blank column on the right. Rank only the diseases that cause economic damage starting with the worst disease as ranking number 1.

Table 1. Ranking of economically important rice diseases problems.

Pest	Ranking*	New Ranking (if applicable)
Stem Rot	1	1
Sheath Spot	2	2
OTHER DISEASES? (Please list and rank if possible)		
Water Molds		3
Kernel Smut		4

* #1 equals most damaging disease of 1993 California rice crop. #2 equals the next most damaging pest of 1993 California rice crop, etc.

Table 2. Impact of the Loss of Disease Control Practices on Rice Production and Use of Alternative Controls.

"Lost" Disease Control Practice	Alternatives Used if Practice is Lost/% Used*	Yield Impact** in Percent (%) if Practice is Lost and Alternatives are: Used	Not Used	Secondary Effects***
Burning of Rice Straw	Control nitrogen rate (minimize). Do not establish overly dense stands. Cut, bail and remove (rice straw).			Do not know impact of long-term use of burning as disease control measure. Bailing and removal of rice straw is not feasible over wide acreage.
Resistant Varieties	No highly resistant varieties available yet - still breeding.			
Straw Incorporation				(Straw incorporation) actually tends to increase stem rot and aggregate sheath spot.
Rotation				Not many acres are rotated and short rotation would not control diseases much.
Flooding				Somewhat up in the air if off-season flooding affects diseases very much.
OTHER DISEASE CONTROL PRACTICES? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" practice that would be treated with the alternative. Alternatives may be fungicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" practice in column 1.

*** Secondary effects due to use of alternatives i.e., development of disease resistance, increased cost of control, diseases not controlled, etc.

FURTHER COMMENTS FROM TABLE 2. CONCERNING:

ALTERNATIVES: Loss of broadleaf herbicides could bring back MCPA which in turn can predispose rice crop to disease (stem rot and maybe aggregate sheath spot). Londax use allows reduced nitrogen use (if not reduced, diseases i.e., stem rot, could increase.

YIELD IMPACTS:

SECONDARY EFFECTS:

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: LOUISIANA - RICE DISEASE CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Louisiana, Arkansas, Texas, California, and Mississippi will be surveyed as part of this assessment. Because of your expertise in the area of rice disease control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Clayton A. Hollier

TITLE: Plant Pathologist

ADDRESS: P.O. Box 25100

Baton Rouge, LA 70894-5100

PHONE #: 504-388-6195

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of disease problems of rice obtained from the 1993 grower survey of pesticide use on rice in Louisiana. Growers were asked to list the disease(s) that caused the greatest money loss in their 1993 rice crop. The diseases are ranked according to the number of growers listing the disease with the most listed disease ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state is an accurate representation of the disease problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the spaces provided. Rank only the diseases that cause economic damage starting with the worst disease as ranking number 1.

Table 1. Ranking of economically important rice diseases problems.

Disease	Ranking*	New Ranking (if applicable)
Sheath Blight	1	1
Blast	2	2
Water Molds	3	3
Straighthead	4	5
Narrow Brown Leaf Spot	5	4
Brown Leaf Spot	5	6
OTHER DISEASES? (Please list and rank if possible)		

* #1 equals most damaging disease of 1993 Louisiana rice crop. #2 equals the next most damaging pest of 1993 Louisiana rice crop, etc.

RICE DISEASES - LOUISIANA

Table 2. Impact of the Loss of Individual Fungicides on Rice Production and Use of Alternative Controls.

"Lost" Fungicide	Alternatives Used if Fungicide is Lost/% Used*	Yield Impact** in Percent (%) if Fungicide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
benomyl	iprodione/25%, propiconazole/25%	(-)5	(-)15	None
iprodione	benomyl/10%, propiconazole/10%	(+)3	(-)12	None
propiconazole	benomyl/10%, iprodione/10%	0	(-)12	None
OTHER FUNGICIDES? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" fungicide that would be treated with the alternative. Alternatives may be other fungicide or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" fungicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of disease resistance, increased cost of control, weeds not controlled, etc.

RICE DISEASES - LOUISIANA

FURTHER COMMENTS FROM TABLE 2. CONCERNING:

ALTERNATIVES: The assumption with alternative fungicides is that the disease trying to be managed is sheath blight. If blast is the one in question, there is no alternative to Benlate (benomyl). The other products have no activity against Pyricularia grisea.

YIELD IMPACTS:

SECONDARY EFFECTS:

Table 3. Impact of the Loss of Groups of Fungicides on Rice Production and Use of Alternative Controls.

"Lost" Fungicide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Fungicide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
ALL FUNGICIDES	No additional ones. Cultural practices, resistance, etc. are already in use.	(-)15	(-)15	Diseases (especially sheath blight and blast) not controlled.
OTHER FUNGICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" fungicide group that would be treated with the alternative. Alternatives may be other fungicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" fungicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of disease resistance, increased cost of control, diseases not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: TEXAS - RICE DISEASE CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Texas, Arkansas, Mississippi, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice disease control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Joseph P. Krausz

TITLE: Extension Plant Pathologist

ADDRESS: 118 Peterson Bldg, Texas A&M University

College Station, TX 77843-2132

PHONE #:409-845-8032

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of disease problems of rice obtained from the 1993 grower survey of pesticide use on rice in Texas. Growers were asked to list the disease(s) that caused the greatest money loss in their 1993 rice crop. The diseases are ranked according to the number of growers listing the disease with the most listed disease ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state is an accurate representation of the disease problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the blank column on the right. Rank only the diseases that cause economic damage starting with the worst disease as ranking number 1.

Table 1. Ranking of economically important rice diseases problems.

Disease	Ranking*	New Ranking (if applicable)
Sheath Blight	1	1
Rice Blast	2	2
Narrow Brown Leafspot	3	3
Black Sheath Rot	4	4
Stem Rot	5	5
Brown Leafspot	6	7
Straighthead**	6	7
Bacterial Leaf Blight	7	8
Kernel Smut	7	6
Leaf Smut	7	7
OTHER DISEASES? (Please list and rank if possible)		

* #1 equals most damaging disease of 1993 Texas rice crop. #2 equals the next most damaging pest of 1993 Texas rice crop, etc.

** Straighthead is not a true disease but a physiological disorder.

Table 2. Impact of the Loss of Individual Fungicides on Rice Production and Use of Alternative Controls.

"Lost" Fungicide	Alternatives Used if Fungicide is Lost/% Used*	Yield Impact** in Percent (%) if Fungicide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
benomyl	propiconazole/40%, iprodione/10%	(-)2	(-)9	Greater risk to the very damaging and potentially explosive blast disease which is only controlled by benomyl.
propiconazole	benomyl/60%, iprodione/30%	(-)2	(-)9	
iprodione	benomyl/30%, propiconazole/70%	(+)2	(-)8	
copper sulfate	propiconazole/30%, benomyl/30%, iprodione/20%	(+)6	(-)4	

* Percentage used denotes the percentage of the acreage currently treated by the "lost" fungicide that would be treated with the alternative. Alternatives may be other fungicide or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" fungicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of disease resistance, increased cost of control, diseases not controlled, etc.

FURTHER COMMENTS FROM TABLE 2. CONCERNING:

ALTERNATIVES: Benomyl has a characteristic that is hard to properly evaluate in surveys such as this one. It is the only product that is effective against blast, a very damaging disease, but very erratic in its year-to-year occurrence and damage. When blast is active during some years, benomyl's importance to the rice industry increases tremendously.

YIELD IMPACTS:

SECONDARY EFFECTS:

Table 3. Impact of the Loss of Groups of Fungicides on Rice Production and Use of Alternative Controls.

"Lost" Fungicide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Fungicide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
ALL FUNGICIDES	No adequate alternatives.	(-)9	(-)9	
OTHER FUNGICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" fungicide that would be treated with the alternative. Alternatives may be other fungicides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" fungicide in column 1.

*** Secondary effects due to use of alternatives i.e., development of disease resistance, increased cost of control, diseases not controlled, etc.

FURTHER COMMENTS FROM TABLE 3. CONCERNING:

ALTERNATIVES: There are some cultural alternatives which I chose not to list because a single table does not adequately reflect their impact. Such practices are: early planting, nitrogen management, proper seeding rate, skip-row planting, "resistant" varieties for blast, and "tolerant" varieties for blast, etc. None, or all, of these are often not adequate and fungicides are a must. I do not know of an adequate and acceptable to list all these cultural practices in Table 3 and their impact on yields. So I have listed "no adequate alternatives" as the more appropriate response. Also many of these practices are used in addition to fungicides, so they are not always "alternatives" but "complementary" practices.

YIELD IMPACTS:

SECONDARY EFFECTS:

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: ARKANSAS - RICE INSECT CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Arkansas, Mississippi, Texas, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice insect control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Don Johnson

TITLE: Extension Entomologist

ADDRESS: P.O. Box 391

Little Rock, AR 72203

PHONE #:501-671-2229

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of insect pests of rice obtained from the 1992 grower survey of pesticide use on rice in Arkansas. Growers were asked to list the insect(s) that caused the greatest money loss in their 1992 rice crop. The insects are ranked according to the number of growers listing the insect with the most listed insect ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state in 1992 is an accurate representation of the insect problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the spaces provided. Rank only the insects that cause economic damage starting with the worst insect as ranking number 1.

Table 1. Ranking of economically important rice insect pests.

Insect	Ranking*	New Ranking (if applicable)
Stinkbug	1	1
Grasshopper	2	4
Rice Water Weevil	3	2
Armyworm	4	3
Rice Stem Borer	5	5
Chinchbug	6	6
OTHER INSECT PESTS? (Please list and rank if possible)		

* #1 equals most damaging insect of 1993 Arkansas rice crop. #2 equals next most damaging insect of 1993 Arkansas rice crop, etc.

Table 2. Impact of the Loss of Individual Insecticides on Rice Production and Use of Alternative Controls.

"Lost" Insecticide	Alternatives Used if Insecticide is Lost/% Used*	Yield Impact** in Percent (%) if Insecticide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
carbaryl	malathion/50%, methyl parathion/50%	(-)5	(-)30	None
carbofuran	No chemical alternatives, Cultural practices, Drainage/50%	(-)20	(-)40	Poor control. Economic loss because of water loss - drainage.
malathion	carbaryl/50%, methyl parathion/50%	(-)10	(-)30	Some propanil insecticide interactions damage to plants.
methyl parathion	malathion/50%, carbaryl/50%	(-)10	(-)30	Some propanil insecticide interactions damage to plants.
OTHER INSECTICIDES? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" pesticide that would be treated with the alternative. Alternatives may be other pesticides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" insecticide in column 1.

*** Secondary effects due to use of alternatives i.e., development of insect resistance, increase cost of control, insects not controlled, etc.

Table 3. Impact of the Loss of Groups of Insecticides on Rice Production and Use of Alternative Controls.

"Lost" Insecticide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Insecticide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
Carbamates (carbaryl, carbofuran)	Organophosphates/50%, Drainage for rice water weevil/50%	(-)20	(-)40	
Organophosphates (malathion, methyl parathion)	Carbamates	(-)30	(-)25	Propanil/insecticide damage would be severe.
ALL INSECTICIDES	Drainage for rice water weevil	(-)30	(-)35	
OTHER INSECTICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" insecticide group that would be treated with the alternative. Alternatives may be other pesticide or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" insecticide group in column 1.

*** Secondary effects due to use of alternatives i.e., development of insect resistance, increase cost of control, insects not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: ARKANSAS - RICE INSECT CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Arkansas, Mississippi, Texas, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice insect control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Nathan A. Slaton

TITLE: Area Rice Specialist

ADDRESS: P.O. Box 351

Stuttgart, AR 72160

PHONE #: 501-673-2661

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of insect pests of rice obtained from the 1992 grower survey of pesticide use on rice in Arkansas. Growers were asked to list the insect(s) that caused the greatest money loss in their 1992 rice crop. The insects are ranked according to the number of growers listing the insect with the most listed insect ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state in 1992 is an accurate representation of the insect problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the spaces provided. Rank only the insects that cause economic damage starting with the worst insect as ranking number 1.

Table 1. Ranking of economically important rice insect pests.

Insect	Ranking*	New Ranking (if applicable)
Stinkbug	1	1
Grasshopper	2	3
Rice Water Weevil	3	2
Armyworm	4	5
Rice Stem Borer	5	6
Chinchbug	6	4
OTHER INSECT PESTS? (Please list and rank if possible)		
Billbug		7

* #1 equals most damaging insect of 1993 Arkansas rice crop. #2 equals next most damaging insect of 1993 Arkansas rice crop, etc.

Table 2. Impact of the Loss of Individual Insecticides on Rice Production and Use of Alternative Controls.

"Lost" Insecticide	Alternatives Used if Insecticide is Lost/% Used*	Yield Impact** in Percent (%) if Insecticide is Lost and Alternatives are:		Secondary Effects***
		Used	Not Used	
carbaryl	Malathion/50%, Methyl parathion/50%	0	(-)10 to (-)20	
carbofuran	Drain and dry fields/10%	(-)5	(-)10	Not feasible on many fields since other production factors influenced weed control, water use, nitrogen use would increase.
malathion	carbaryl/50%, methyl parathion/50%	0	(-)10 to (-)20	
methyl parathion	malathion/50%, carbaryl/50%	0	(-)10 to (-)20	
OTHER INSECTICIDES? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" pesticide that would be treated with the alternative. Alternatives may be other pesticides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" insecticide in column 1.

*** Secondary effects due to use of alternatives i.e., development of insect resistance, increase cost of control, insects not controlled, etc.

Table 3. Impact of the Loss of Groups of Insecticides on Rice Production and Use of Alternative Controls.

"Lost" Insecticide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Insecticide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
Carbamates (carbaryl, carbofuran)	organophosphates/100%, Drainage for water weevil/20%	(-)5	(-)10 to (-)20	
Organophosphates (malathion, methyl parathion)	carbaryl/100%	0	(-)10	
ALL INSECTICIDES	Very few alternatives	(-)25	(-)25	
OTHER INSECTICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" insecticide group that would be treated with the alternative. Alternatives may be other pesticide or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" insecticide group in column 1.

*** Secondary effects due to use of alternatives i.e., development of insect resistance, increase cost of control, insects not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: CALIFORNIA - RICE INSECT CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in California, Arkansas, Texas, Mississippi, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice insect control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Larry Godfrey

TITLE: Extension Entomologist/Assistant Entomologist

ADDRESS: Dept. of Entomology, University of California

Davis, CA 95616

PHONE #: 916-752-0473

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of insect pests of rice obtained from the 1993 grower survey of pesticide use on rice in California. Growers were asked to list the insect(s) that caused the greatest money loss in their 1993 rice crop. The insects are ranked according to the number of growers listing the insect with the most listed insect ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state is an accurate representation of the insect problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the blank column on the right. Rank only the insects that cause economic damage starting with the worst insect as ranking number 1.

Table 1. Ranking of economically important rice insect pests.

Insect	Ranking*	New Ranking (if applicable)
Rice Water Weevil	1	1
Tadpole Shrimp	2	2
Crayfish	3	3
OTHER INSECTS? (Please list and rank if possible)		
Rice seed midges		4
Rice leafminer		5
Armyworms		6

* #1 equals most damaging insect of 1993 California rice crop. #2 equals next most damaging insect of 1993 California rice crop, etc.

Table 2. Impact of the Loss of Individual Insecticides on Rice Production and Use of Alternative Controls.

"Lost" Insecticide	Alternatives Used if Insecticide is Lost/% Used*	Yield Impact** in Percent (%) if Insecticide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
carbofuran	No insecticide alternatives registered. 1) clean levee vegetation 2) delay planting date 3) drill seeding	1) (-)3 to (-)4 2) (-)4 3) >(-)5	1) (-)5 to (-)10 2) (-)5 to (-)10 3) (-)5 to (-)10	(Yield impact) extremely variable over areas and years. (Clean levee vegetation results in) destruction of avian/wildlife habitat. (Delaying planting date results in) less efficient use of resources. (Drill seeding results in) more weed infestation problems, reduced yield.
copper sulfate	Carbaryl, methyl parathion	(-)3 to (-)4	Variable 0 to (-)10	More environmental hazard. Algal blooms not controlled.
methyl parathion	Malathion (for rice leafminer)	0 to (-)1	0 to (-)2	
OTHER INSECTICIDES? (Please list)				
malathion	Lower water depth during cool weather			(Alternative) promotes weed growth.
carbaryl	Malathion, copper sulfate			

* Percentage used denotes the percentage of the acreage currently treated by the "lost" pesticide that would be treated with the alternative. Alternatives may be other pesticides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" insecticide in column 1.

*** Secondary effects due to use of alternatives i.e., development of insect resistance, increased cost of control, insects not controlled, etc.

Table 3. Impact of the Loss of Groups of Insecticides on Rice Production and Use of Alternative Controls.

"Lost" Insecticide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Insecticide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
Carbamates	No alternatives. See previous table.			
Organophosphates	See previous table.			
ALL INSECTICIDES	1) Cultural controls 2) host plant resistance 3) biological control i.e., bioinsecticides, biological control with other insects			All of the cultural controls have significant drawbacks as shown in the previous table. (Host plant resistance) is being worked on but yield potential is still low and grain is of poorer quality. Nothing (bioinsecticides) available at this time. Same for biological control with other insects. Both types of biocontrol need further research but the research to date has shown no "silver bullets".
OTHER INSECTICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" insecticide group that would be treated with the alternative. Alternatives may be other pesticide or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" insecticide group in column 1.

*** Secondary effects due to use of alternatives i.e., development of insect resistance, increased cost of control, insects not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: LOUISIANA - RICE INSECT CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Louisiana, Arkansas, Texas, California, and Mississippi will be surveyed as part of this assessment. Because of your expertise in the area of rice insect control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Jack L. Bagent

TITLE: Extension Specialist (Entomology)

ADDRESS: Knapp Hall, Louisiana State University

Baton Rouge, LA 70803

PHONE #: 504-388-5336

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of insect pests of rice obtained from the 1993 grower survey of pesticide use on rice in Louisiana. Growers were asked to list the insect(s) that caused the greatest money loss in their 1993 rice crop. The insects are ranked according to the number of growers listing the insect with the most listed insect ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state is an accurate representation of the insect problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the spaces provided. Rank only the insects that cause economic damage starting with the worst insect as ranking number 1.

Table 1. Ranking of economically important rice insect pests.

Insect	Ranking*	New Ranking (if applicable)
Rice Water Weevil	1	1
Stinkbug	2	2
Grasshopper	3	6
Rice Leaf Miner	4	4
OTHER INSECTS? (Please list and rank if possible)		
Armyworm		3
Chinch bug		5

* #1 equals most damaging insect of 1993 Louisiana rice crop. #2 equals next most damaging insect of 1993 Louisiana rice crop, etc.

Table 2. Impact of the Loss of Individual Insecticides on Rice Production and Use of Alternative Controls.

"Lost" Insecticide	Alternatives Used if Insecticide is Lost/% Used*	Yield Impact** in Percent (%) if Insecticide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
carbaryl	malathion/100%	(+)1	(-)1	No effect.
carbofuran	No chemical alternative. Drain fields/10%	(+)5	(-)10	Increases weed control costs and water useage.
malathion	carbaryl and methyl parathion	(+)4	(-)4	Used in and around sensitive areas, including crawfish ponds.
methyl parathion	malathion	(+)5	(-)5	Increases cost of insecticide.
OTHER INSECTICIDES? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" pesticide that would be treated with the alternative. Alternatives may be other pesticides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" insecticide in column 1.

*** Secondary effects due to use of alternatives i.e., development of insect resistance, increased cost of control, insects not controlled, etc.

Table 3. Impact of the Loss of Groups of Insecticides on Rice Production and Use of Alternative Controls.

"Lost" Insecticide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Insecticide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
Carbamates	Drainage for rice water weevil.	(-)5	(-)10	Not a reliable means of control; increased herbicide usage; increased water costs.
Organophosphates	Carbamates	(-)1	(-)5	Organophosphates are generally cheaper; malathion is used in crawfish ponds double cropped with rice; carbaryl cannot be used.
ALL INSECTICIDES		(-)6	(-)15	
OTHER INSECTICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" insecticide group that would be treated with the alternative. Alternatives may be other pesticide or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" insecticide group in column 1.

*** Secondary effects due to use of alternatives i.e., development of insect resistance, increased cost of control, insects not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: TEXAS - RICE INSECT CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Texas, Arkansas, Mississippi, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice insect control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: Bastiaan M. Drees

TITLE: Professor and Extension Entomologist

ADDRESS: P.O. Box 2150

Bryan, TX 77806

PHONE #: 409-845-6800

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of insect pests of rice obtained from the 1993 grower survey of pesticide use on rice in Texas. Growers were asked to list the insect(s) that caused the greatest money loss in their 1993 rice crop. The insects are ranked according to the number of growers listing the insect with the most listed insect ranked as number 1.

   A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state is an accurate representation of the insect problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

   B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the blank column on the right. Rank only the insects that cause economic damage starting with the worst insect as ranking number 1.

Table 1. Ranking of economically important rice insect pests.

Insect	Ranking*	New Ranking (if applicable)
Rice Stinkbug	1	NO CHANGES
Rice Water Weevil	2	
Armyworm	3	
Grasshopper	4	
Chinchbug	5	
Rice Borers (Sugarcane borer)	6	
Rice Seed Midge	6	
OTHER INSECTS? (Please list and rank if possible)		

* #1 equals most damaging insect of 1993 Texas rice crop. #2 equals next most damaging insect of 1993 Texas rice crop, etc.

Table 2. Impact of the Loss of Individual Insecticides on Rice Production and Use of Alternative Controls.

"Lost" Insecticide	Alternatives Used if Insecticide is Lost/% Used*	Yield Impact** in Percent (%) if Insecticide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
methyl parathion	Carbaryl, malathion	0	0 to (-)9	Grade loss due to stink bugs only.
carbaryl	methyl parathion, malathion	0	0 to (-)9	Grade loss due to stink bugs only.
carbofuran	None	(-)10 to (-)15	(-)10 to (-)15	
cyhalothrin				
malathion	methyl parathion, carbaryl	0	0 to (-)9	Grade loss due to stink bugs only.
OTHER INSECTICIDES? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" pesticide that would be treated with the alternative. Alternatives may be other pesticides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" insecticide in column 1.

*** Secondary effects due to use of alternatives i.e., development of insect resistance, increased cost of control, insects not controlled, etc.

FURTHER COMMENTS FROM TABLE 2. CONCERNING:

ALTERNATIVES: We have no assessment on minor pests (sugarcane borer, armyworm, chinch bugs, leafhoppers, grasshoppers, etc.) as to whether they cause yield loss, how much or whether control is economically justified.

YIELD IMPACTS:

SECONDARY EFFECTS:

Table 3. Impact of the Loss of Groups of Insecticides on Rice Production and Use of Alternative Controls.

"Lost" Insecticide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Insecticide Group is Lost and Alternatives are: Used	Not Used	Secondary Effects***
Organophosphates (methyl parathion, malathion)	Carbamates	0	0 to (-)9	Grade loss due to stink bugs only.
Carbamates (carbaryl, carbofuran)	organophosphates	(-)10 to (-)15	(-)15 to (-)25	
ALL INSECTICIDES	Cultural practices	(-)10 to (-)15	(-)15 to (-)25	
OTHER INSECTICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" insecticide group that would be treated with the alternative. Alternatives may be other pesticide or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" insecticide group in column 1.

*** Secondary effects due to use of alternatives i.e., development of insect resistance, increased cost of control, insects not controlled, etc.

ECONOMIC AND BIOLOGIC ASSESSMENT OF PESTICIDE USE ON RICE

RICE SPECIALIST SURVEY

Funded by: United States Department of Agriculture
National Agricultural Pesticide Impact Assessment Program
In Cooperation with: Cooperative Extension Service
University of Arkansas

STATE: TEXAS - RICE INSECT CONTROL

The data generated by this survey will be incorporated into a national assessment of pesticide use in rice. Rice growers in Texas, Arkansas, Mississippi, California, and Louisiana will be surveyed as part of this assessment. Because of your expertise in the area of rice insect control you are being asked to provide information that cannot reliably be obtained from growers.

The analysis of the data and the resulting publication will be coordinated in Arkansas with help from rice specialists in the participating states.

The information summarized from this study will be made available to the USDA, officials and representatives in the various states government, the Environmental Protection Agency, members of Congress, and all interested citizens. Hopefully this information will encourage increased support for research and education to solve the pest management problems of rice growers.

NAME OF RESPONDING SPECIALIST/RESEARCHER: M.O. Way

TITLE: Associate Professor

ADDRESS: TAES, Route 7, Box 999

Beaumont, TX 77713

PHONE #: 409-752-2741

1. PEST RANKING - Provided on the next page in Table 1 are the ranking of insect pests of rice obtained from the 1993 grower survey of pesticide use on rice in Texas. Growers were asked to list the insect(s) that caused the greatest money loss in their 1993 rice crop. The insects are ranked according to the number of growers listing the insect with the most listed insect ranked as number 1.

    A. REVIEW THE RANKING FOR YOUR STATE - If you feel the ranking presented in Table 1 for your state is an accurate representation of the insect problems for an average year then please indicate this somewhere on the chart. Otherwise, proceed to part B.

    B. CORRECT YOUR STATE'S RANKING - If you feel the rankings are not correct or require additions, fill in what you think needs correcting in the blank column on the right. Rank only the insects that cause economic damage starting with the worst insect as ranking number 1.

Table 1. Ranking of economically important rice insect pests.

Insect	Ranking*	New Ranking (if applicable)
Rice Stinkbug	1	2
Rice Water Weevil	2	1
Armyworm	3	
Grasshopper	4	5
Chinchbug	5	4
Stem Borers (Sugarcane borer)	6	
Rice Seed Midge	6	
OTHER INSECTS? (Please list and rank if possible)		

* #1 equals most damaging insect of 1993 Texas rice crop. #2 equals next most damaging insect of 1993 Texas rice crop, etc.

Table 2. Impact of the Loss of Individual Insecticides on Rice Production and Use of Alternative Controls.

"Lost" Insecticide	Alternatives Used if Insecticide is Lost/% Used*	Yield Impact** in Percent (%) if Insecticide is Lost and Alternatives are: Used	Not Used	Secondary Effects***
methyl parathion	carbaryl/100%	See "Secondary Effects"	See "Secondary Effects"	Rice stinkbug does not affect yield; only quality. If methyl parathion were lost, carbaryl would replace it with no change in yield or quality but an increase in production costs because carbaryl is more expensive than methyl parathion. Carbaryl is not as effective as methyl parathion in controlling rice stinkbug.
carbaryl	methyl parathion/100%	See "Secondary Effects"	See "Secondary Effects"	Same as above. However, if both carbaryl and methyl parathion were lost, then quality would be significantly affected!
carbofuran	No reliable alternative (draining fields or delaying flood are poor alternatives).	No effective, reliable alternatives.	(-)10	Draining fields or delaying flood can increase herbicide, fertilizer, water, and labor costs and delay maturity - not reliable or effective alternatives.
cyhalothrin (cyhalothrin received a Crisis Exemption in 1993 for fall armyworm)	methyl parathion/50%, Bacillus thuringiensis/5%, Flushing or applying early permanent flood/45%	See "Secondary Effects"	See "Secondary Effects"	Fall armyworm is a sporadic pest (can destroy entire fields of seedling rice - in these cases, total loss can occur. Small rice cannot tolerate permanent flood and methyl parathion can interact with propanil; thus, in these cases loss of cyhalothrin equals total field loss causing farmer to re-seed or abandon field.
Bacillus thuringiensis	methyl parathion/100%			Very little (Bacillus thuringiensis) is applied - not very effective.

* Percentage used denotes the percentage of the acreage currently treated by the "lost" pesticide that would be treated with the alternative. Alternatives may be other pesticides or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" insecticide in column 1.

*** Secondary effects due to use of alternatives i.e., development of insect resistance, increased cost of control, insects not controlled, etc.

FURTHER COMMENTS FROM TABLE 2. CONCERNING:

ALTERNATIVES: No alternatives to carbofuran - without carbofuran yields will decrease about 10%. See comments in Table.

YIELD IMPACTS: See comments in Table. Rice stink bug does not reduce yield (our field data indicate this) given average population densities; however, quality is reduced. This represents an important economic loss.

SECONDARY EFFECTS: See comments in Table.

Table 3. Impact of the Loss of Groups of Insecticides on Rice Production and Use of Alternative Controls.

"Lost" Insecticide Group	Alternatives Used if Group is Lost/% Used*	Yield Impact** in Percent (%) if Insecticide Group is Lost and Alternatives are:		Secondary Effects***
		Used	Not Used	
Organophosphates (methyl parathion, malathion)	carbaryl/100%	See "Secondary Effects"	See "Secondary Effects"	Rice stink bug does not reduce yield - reduces quality. Loss of methyl parathion would have major impact because of increased cost of control when carbaryl is used.
Carbamates (carbaryl, carbofuran)	No reliable, effective alternatives to carbofuran.	NA	(-)10	Draining fields not reliable control for rice water weevil.
ALL INSECTICIDES	Delaying flood/5%, Draining fields/50%, Applying flushes/10%	(-)10	>(-)15	Value of quality reduction due to failure to control rice stink bug. (Alternatives for all insecticides are for) rice water weevil and fall armyworm. <u>No alternative</u> for control of rice stink bug if we lose all insecticides!
OTHER INSECTICIDE GROUPS? (Please list)				

* Percentage used denotes the percentage of the acreage currently treated by the "lost" insecticide group that would be treated with the alternative. Alternatives may be other pesticide or non-pesticide controls.

** Yield impact may be plus (+) or minus (-) and should represent the effect on the rice acreage currently treated with the "lost" insecticide group in column 1.

*** Secondary effects due to use of alternatives i.e., development of insect resistance, increased cost of control, insects not controlled, etc.

FURTHER COMMENTS FROM TABLE 3. CONCERNING:

ALTERNATIVES: See previous Table.

YIELD IMPACTS: Brorsen, Grant and Rister (1984)* found that a 1% point decrease in "peck" was worth between about \$20 to \$65/A. If we assume that insecticide applications, in general, lower "peck" 1% point then Texas farmers would lose between \$3 and \$9.75 million (minus control costs) annually given withdrawal of insecticides on 150,000 acres (assume about 1/2 of Texas acreage is treated for rice stink bug.

* Brorsen, B.W., W.R. Grant, and M.E. Rister. 1984. A Hedonic Price Model for Rough Rice Bid/Acceptance Markets. American Journal of Agricultural Economics. 66:156-163.

SECONDARY EFFECTS: See Table.

APPENDIX E.

Benomyl Benefits Assessment on Rice in the Southern U.S.

Louisiana State University
Agricultural Center
Louisiana Agricultural Experiment Station

Rice Research Station
Post Office Box 1429
Crowley, LA 70527 1429
(318) 788 7531
Fax (318) 788 7553

April 1, 1993

Public Response and Program Resources Branch
Field Operations Division (H7506C)
Office of Pesticide Programs
401 M St., S.W.
Washington, DC 20460

To Whom This May Concern:

I am writing to comment on the proposal to permit the U.S. Environmental Protection Agency to set tolerance levels for pesticides. I am writing on behalf of the National Rice Research Board and the Rice Research Boards in Arkansas, Louisiana, Mississippi, and Texas. I am also writing on behalf of rice producers in the south as well as the state of Louisiana.

We appreciate the opportunity to comment on the above proposal. We believe that the Environmental Protection Agency should have the authority to set reasonable and prudent tolerance levels for pesticides based on scientific data, good manufacturing processes, and at the ready to eat stage. This is especially important due to the increased accuracy of scientific instrumentation. Furthermore, the ability of the scientists to measure and detect residues has increased tremendously in recent years. Today, we speak not only in terms of parts per million, but also in terms of parts per billion and trillion. Consequently, zero levels are becoming increasingly and infinitely small. Based on current scientific detection technology, a zero tolerance level may be impossible to achieve. We are in support of efforts to permit U.S.E.P.A. to establish tolerance levels in lieu of the Delaney Clause.

I have attached a statement indicating the potential impact upon rice production in the south if the use of benomyl was not permitted on rice. Benomyl is the only effective registered and approved pesticide for use to control "blast" (*Pyricularia grisea*) in the production of rice. The loss of this material would be devastating to the southern rice industry. The incidence of blast disease has been epidemic, or bordering on epidemic, in the southern states in recent years. In the absences of approved and effective materials, economic losses from blast would severally effect the southern

rice industry amounting to as much as $85 million per year. Currently, the United States is importing a fairly significant quantity of rice from Thailand. This imported rice consists primarily of types that are not available in the United States. The southern rice industry is currently facing severe economic difficulty due to low prices in the world market. The loss of an effective and approved means of controlling the blast disease could result in seriously impairing the ability of the southern rice industry to meet domestic consumer demand. This could result in increased imports of rice from Thailand and other countries. Thailand producers and producers in other parts of the world have the option to utilize pesticides that are no longer approved for use in the United States. Consequently, the American consumer would be exposed to severe health hazards due to consumption of foreign produced food, which would not even come close to meeting current E.P.A. standards, much less the Delaney Clause.

In my opinion, the U.S. Environmental Protection Agency and the U.S. agricultural production system must work closely together to assure that the American consumer has available food products that are wholesome, nutritious, and safe.

As I mentioned earlier, I have attached an impact statement relative to the impact upon the southern rice industry if benomyl was not approved for use on rice. This statement addresses the type of information solicited by U.S.E.P.A. Consequently, it is intended to be a part of this letter and includes appropriate comments.

Again, thank you for the opportunity to comment on this important issue.

Sincerely,

J. A. Musick

J. A. Musick
Resident Director

kgg
Enclosure

BENOMYL BENEFITS ASSESSMENT ON RICE IN THE SOUTHERN UNITED STATES

OVERVIEW

ECONOMIC BENEFITS OF BENOMYL:

Between 1988 - 1992, approximately 2.77 million acres of rice were planted annually in the six rice-producing states of the United States producing a crop with an average annual farm value of about $1.1 billion. Based on estimated production multipliers developed by Texas A&M University for agricultural commodities, rice production in the southern United States has an annual economic impact of approximately $2.96 billion.

Data from research tests suggest that rice diseases annually cause at least an average range of 12 - 15% loss in yield in the South. With present production costs and price of rice, this average yield loss translates into an average 33 - 40% loss in potential net return due to rice diseases. Fungicides play an important role in limiting these losses. Benomyl is one of only four fungicides presently registered on rice in the United States. Benomyl has activity against several important rice diseases, including sheath blight (*Rhizoctonia solani*), rice blast (*Pyricularia grisea*), narrow brown leaf spot (*Cercospora oryzae*), black sheath rot (*Gaeumannomyces graminis var. graminis*), and stem rot (*Sclerotium oryzae*). However, it is the <u>ONLY</u> product available that is effective against the devastating rice blast. Fortunately, rice blast epidemics historically have occurred only sporadically across much of the Southern rice belt, however, rice blast epidemics have been more frequent in recent years. The use of benomyl is usually less compared with alternative products when rice blast is not a problem. When and where rice blast is a threat, benomyl often is <u>essential</u> in preventing serious losses.

In the rice blast epidemics of 1991 and 1992 in the South, blast-susceptible varieties sustained yield losses of up to 60% with grain of exceptionally poor quality remaining. Often the loss from poor milling and subsequent reduction in grade were more devastating than the yield loss. In Arkansas, blast epidemics began in 1986 and have continued to cause losses as high as 75-80% in individual grower production fields. In test results from field locations during the blast epidemics of 1991 and 1992, benomyl gave an average yield increase of 27% by controlling blast. Estimates of the quantity of benomyl applied on the Southern rice crop during these years indicates that 1.0 million acres (33% of the total planted acres) were treated annually saving 13.6 million cwt of rough rice valued at approximately $84.4 million for each of 1991 and 1992 using an average loan price of $6.50/cwt. Grain quality or milling yields were also improved. Based on tests, the average increase in grain yield after milling was an additional 5.6% and the increase in whole (unbroken) grains was 2.8%. Results of economic analysis has shown an increase of $0.69/cwt in the value of rice from benomyl treated rice over non-treated rice. This further added to the value of the crop.

In years when the incidence of blast is low, approximately 637,000 acres of rice (23% of the total planted acres) are treated with benomyl. The primary target for these applications is the control of sheath blight. Field tests over several years show an average yield increase of 12% with benomyl due to control of sheath blight, narrow brown leaf spot, black sheath rot, and stem rot. This saves the producers about $27.5 million each year. Again, additional benefits include increased quality through increased milling.

NATURE AND EXTENT OF USE OF BENOMYL ON RICE IN SOUTHERN UNITED STATES:

* **Acres treated:**

    1) In rice blast epidemic years: 1.0 million acres
    2) In low blast-incidence years: 637,000 acres

* **Typical rate and time of application:**

0.5 lb a.i./A from PD (panicle differentiation) to mid-boot and a second application at 80% heading.

NATURE AND EXTENT OF USE OF BENOMYL ON RICE IN SOUTHERN UNITED STATES: Cont.

* **Rice Pathogens (diseases) controlled:**

    1) *Pyricularia grisea* (rice blast)
    2) *Rhizoctonia solani* (sheath blight)
    3) *Cercospora oryzae* (narrow brown leaf spot)
    4) *Gaeumannomyces graminis var. graminis* (black sheath rot)
    5) *Sclerotium oryzae* (stem rot)

* **Alternative Controls:**

Chemical:
Benomyl is the only registered fungicide for use on rice in the United States that is effective against rice blast. Against sheath blight, narrow brown leaf spot and black sheath rot, Tilt (propiconazole) gives equal or slightly superior control. Rovral is about equally effective against sheath blight, but is inferior in control of the other disease.

Non-chemical:

The majority of rice growers seek to incorporate cultural control practices into an integrated pest management system to lessen disease incidence and severity. These measures by themselves are usually inadequate in obtaining satisfactory disease

control. These practices include:

1) Timely planting
2) Avoiding excessive nitrogen fertilization
3) Avoiding excessive seeding rates
4) Maintaining an adequate flood
5) Use of varieties with moderate levels of disease resistance in conjunction with good agronomic characteristics

Rice pathologists and breeders in the United States, and throughout the world, have been actively searching for resistance to major pathogens and incorporating resistance into commercial varieties. The incorporation of multiple resistance into commercial varieties has been a complex, long-term undertaking. Resistance to some of the major diseases has been incorporated into rice cultivars. However, several problems have been encountered in programs with primary emphasis on inherent resistance for disease control, such as no sources of durable resistance have been found for several important diseases and much of the inherent resistance currently being used in rice is of the vertical or monogenic type. Pathogens, especially the blast fungus, often overcome this type of resistance soon after a variety is released because of the intense selection pressure on the pathogen. Variants in the pathogen population that can overcome the specific resistance mechanism(s) become predominant on that variety and are considered new races of the pathogen. This leads to a cyclic phenomenon where resistance is located, incorporated into desirable varieties, becomes widely disseminated as planting of the variety increases, races of the pathogen develop that can break resistance, epidemics occur, new sources of resistance are located, and so on *ad infinitum*. Fungicides provide an important backup control method when host resistance fails. Pathogens also appear to be less likely to develop resistance to pesticides than they are to break resistance in the host.

At present little, if any, true resistance to sheath blight is available in most of the superior commercially available rice varieties. The cultivars Maybelle, Jackson, Alan and Katy seem to sustain less loss to sheath blight than most long grain varieties, and the combined acreage of these varieties has recently increased. However, they tend to yield less than the widely planted Gulfmont and Lemont cultivars and have poorer milling yields. Therefore, cultivar resistance to sheath blight had limited impact on sheath blight control.

None of the widely grown long grain rice cultivars except Katy, have high levels of resistance to the prevailing races (IC-17 and IB-49) of the rice blast pathogen. Moderate levels of resistance (polygenic or rate-reducing resistance) exist in some of the widely planted cultivars such as Gulfmont, Lemont and Alan and this resistance is very helpful in suppressing potential losses to rice blast. However, when environmental conditions remain favorable for blast development, this resistance is often inadequate to prevent serious losses. In a recent fungicide test, a 20% yield increase was obtained with fungicide in the moderately resistant cultivar Gulfmont. With the present available levels of resistance to rice blast, benomyl is still essential to avoid severe losses when blast becomes epidemic.

A solution to these problems is to integrate pesticide usage, inherent disease resistance,

cultural practices, legislation and regulation, and biological control into a continuously changing integrated pest management program, which responds to changes affecting each control practice and minimizes the development of epidemic conditions. Fungicides will remain an important component of this system

YIELD BENEFITS OF BENOMYL:

1. AGAINST BLAST:

a) Benlate vs. no fungicide: 27% yield increase over the unsprayed check

b) If Tilt replaces Benlate: 16% yield decrease compared to Benlate*

c) If Rovral replaces Benlate: 16% yield decrease compared to Benlate*

* Residual yield increase probably due to control of other pathogens.

2. AGAINST SHEATH BLIGHT:

a) Benlate vs. no fungicide: 12% yield increase over the unsprayed check

b) If Tilt replaces Benlate: 3% yield increase over Benlate

c) If Rovral replaces Benlate: 2% yield increase over Benlate

COMPARATIVE RISKS OF LIKELY ALTERNATIVES TO BENLATE:

With the loss of Benlate, rice blast epidemics will go unchecked because there are no fungicide alternatives presently available. This puts rice farmers at great risk of catastrophic losses due to the impact of this disease.

SUMMARY:

Benomyl serves a very important role in the rice production system in the South and is especially noted as the only fungicide available that is effective against rice blast, a very serious and destructive disease. Although recommended cultural practices that help to suppress blast and moderately resistant varieties of rice are used extensively in the southern rice producing area, blast still can cause serious losses when environmental conditions favorable for blast development occur and persist over extended periods of time. There presently is no alternative available in the United States that provides the protection from blast that benomyl provides.

Benomyl also serves as a control for other important diseases such as sheath blight, narrow brown leaf spot, black sheath rot, and stem rot. With sheath blight, the alternatives propiconazole (Tilt) and iprodione (Rovral) usually provide equal or slightly better control

of this disease. However, Iprodione is significantly less effective against a number of the other important diseases, including narrow brown leaf spot, black sheath rot, and stem rot.

The loss of benomyl for use in the southern rice industry would have a significant negative impact. Given the difficult economic constraints faced by rice farmers today, the loss of benomyl in the face of a serious rice blast epidemic similar to the epidemic of 1991 and 1992, would undoubtedly permit crop loss serious enough to force many farmers out of rice production.

INDIVIDUAL STATE BENOMYL IMPACT REPORTS ARE APPENDED

APPENDIX I

ARKANSAS BENOMYL BENEFIT ASSESSMENT ON RICE

BENOMYL LOSS IMPACT STATEMENT

Fleet Lee and Gary L. Cloud

Economic benefits to growers, processors, and consumers.

Benomyl is used for rice disease control in Arkansas. Rice is one of the most important cash crops in Arkansas with an estimated farm cash crop value in excess of 500 million dollars annually, second only to chicken production. Approximately one half of the average annual 2.5 million acres of rice in the United States is grown in the eastern one-third of Arkansas. Rice is the mainstay of the local economy in much of this region.

Two diseases, rice blast caused by *Pyricularia grisea* and rice sheath blight caused by *Rhizoctonia solani*, are particularly damaging and often becomes the limiting factor in rice production in Arkansas. The air-borne blast pathogen is very dynamic and virulent races generally develop on resistant varieties after a period of time. Newbonnet, a high yielding very desirable long grain cultivar, was released in 1983 as resistant to common blast races but was severely damaged by "new" blast races in 1986 when 60,000 acres were severely damaged by rice blast in a localized epidemic. Blast was widespread throughout Arkansas in 1987 when much larger acreage was severely damaged by rice blast. Losses to rice blast have been estimated to have been between 10 and 20 percent of the total rice production per year during 1987-1992. Rice sheath blight is soilborne and as such is a chronic problem resulting from inoculum overwintering within a field. All rice cultivars are susceptible to sheath blight and losses vary depending on the level of susceptibility. Rough rice yield reductions as high as 50-60 % have been recorded in very susceptible cultivars. The annual loss to rice sheath blight in Arkansas is estimated to be between 5 and 15 % of the total state production.

Fungicides are used to reduce losses to these diseases and at times mean the difference between a small profit or a net loss for the grower. Benomyl is an essential component of the rice disease control options, particularity in rice blast control. Growers benefit by having benomyl as an option of fungicides which allow the selection of more disease susceptible but higher yielding cultivars. Growers benefit through increased rough rice yield and from an increased milling yield when benomyl is used for disease control.

Processors and consumers benefit from having a more stable supply of higher quality rice.

Nature and Extent of Use (% crop treated, number of acre treated)

Benomyl usage increased dramatically in Arkansas beginning with the severe blast epidemic of 1986. Actual use figures are difficult to obtain. Rice acreage during the 1990, '91, and '92 growing seasons varied from 1.2 to 1.5 million acres. To estimate usage percentages, 1.35 million acres will be used to represent the total rice acres grown in Arkansas during the 1990-92 growing seasons. According to one published chemical

usage report approximately 32% of the total acres planted to rice is treated with benomyl at the rate of 1.0 lbs ai per acre. This information differs slightly from the Arkansas and National Agricultural Statistic Service reports in which 16% of 1.3 million acres planted acres were treated with benomyl at the average rate of 0.73 lbs ai/acre during the 1991 growing season.

Sources: L.B. Gianessi and C.A. Puffer. Fungicide Use in U.S. Crop Production. 1992. Resources for the future. 1616 P Street, N.W. Washington, D.C. 20036
Agricultural Chemical Usage. 1991 Field Crops Summary. March 1992. Ag ch 1 (92). United Stated Department of Agriculture. National Agricultural Statistics Service. Economic Research service. Washington D.C.
Arkansas Farm Report: Agricultural chemical Usage. Arkansas Agricultural Statistics Service. P.O. box 3197. Federal building Room 3408. Little Rock, AR 72203-3197.

Typical rate of application

The typical rate per application for rice blast control is 1.0 lb/acre. This figure can vary, however, from 0.5 to 1.5 lb/acre depending on the disease level and the growers attitude concerning the cost of fungicides. Many growers use a single application at heading, but if blast is present early two applications are used.

The typical rate per application for sheath blight control is 1.5 lb/acre. This figure can also vary from 1.0 to 1.5 lb/acre.

Time of application of pesticides

Benomyl is typically applied at late boot and head exsertion (90% of panicles in the process of exserting from the boot) growth stages to control rice blast. These fungicide timings are effective if the disease does not develop in the field early during vegetative growth stages. If rice blast is detected at high levels in the field during vegetative growth stages spot fungicide applications have been recommended to reduce the inoculum in the field prior to boot and heading growth stages.

Benomyl application to control sheath blight requires treatments to be made earlier in the growing season. Typically, sheath blight fungicides are applied at internode elongation (IE) and 10 to 14 days later if sheath blight threshold levels are reached.

Pests Controlled

Benomyl has activity on the following fungal pathogens:

Pyricularia grisea (Rice Blast)
Rhizoctonia solani (Sheath Blight)
Cochiobolus miyabeanus (Brown Leaf Spot)
Sclerotium oryzae (Stem Rot)
Several fungal head pathogens

Fusarium spp.
Phoma spp.

Likely Alternatives

Chemical.

There are three registered rice fungicides, benomyl (Benlate), propiconazole (Tilt) and iprodione (Rovral).

In terms of controlling rice blast, no fungicides are available to replace benomyl. Top Cop (Stoller Chemical Co. manufacturer), a copper sulfate mixture, is commercially available. However, the product is ineffective in controlling rice blast when comparing the number of applications and rates of each application to benomyl (See Appendix A). Many other products are commercially available which advocate their utility in controlling rice blast. Most of these products, however, are nothing more than fertilizer formulations and therefore have no activity towards *P. grisea*. Currently, no chemical company is attempting to register any new compounds to compete with or replace benomyl. In light of this, if benomyl is removed from the market growers would attempt to utilize other fungicides which have no activity towards *P. grisea* or suffer the losses caused by rice blast.

Fortunately, alternatives for sheath blight control include other commercially available fungicides which are more efficacious for controlling the sheath blight pathogen.

Relative efficacy of alternative fungicides

The diseases present, the cultivar, and the environment are important factors to consider when estimating efficacy of alternate fungicides. Benomyl is a critical component of the total rice blast control program and is the only registered fungicide which exhibits a degree of control. Benomyl complements the inherent level of genetic resistance in the plant but under environmental conditions highly conducive to blast cannot provide complete control of this disease. Copper or copper plus sulfur formulations are the only alternatives for use as a fungicide to control blast. These compounds have a low level of efficacy and would require more frequent applications of higher rates of product to achieve an acceptable level of control. Yield response comparisons between benomyl and Top Cop in controlling rice blast are shown in Appendix A. In general, there is some response to Top Cop application but the rough rice and milling yield responses are not significantly different from those of the untreated check.

Propiconazole (Tilt) and iprodione (Rovral) do not control rice blast but are more efficacious alternatives for rice sheath blight control. However, higher rates of benomyl provide a comparable degree of sheath blight control and serves to limit the price of the alternative fungicides. In those situations where blast and sheath are present at the same time, benomyl is the fungicide of choice.

Propiconazole is marketed as Tilt 3.6 EC. Our research indicates the six fluid ounce formulated application of Tilt is comparable to the one lb formulated per acre application of benomyl when used for sheath blight control. Tilt applications at higher rates provide a better response. Iprodione is marketed as Rovral 50 WP or Rovral 4F. Our research indicates the one-half lb ai per acre application of Rovral is somewhat more efficacious for sheath blight than benomyl.

Non chemical controls

Other alternatives used to control rice blast include various cultural practices such as cultivar selection, water management, field selection, proper fertility program, etc.

Relative efficacy of non-chemical controls

Cultivar resistance is the primary means of disease control in Arkansas. However all popular cultivars are susceptible to blast races present in Arkansas and to sheath blight. The blast pathogen is very dynamic and highly virulent races often develop on resistant varieties. Newbonnet, a good example, was released in 1983 as resistant to then common blast races but was severely damaged by "new" blast races in 1986 and 1987. The Katy cultivar was released in 1989 as being nearly immune to most blast races. We have already identified race IB-33 as being quite virulent on Katy. Race IB-33 has not been found in Katy field samples but, as recently as 1992, has been found in blast samples collected from other cultivars within the state. With time and an increase in acres planted to Katy, race shifts in the *P. grisea* population are likely to result in an increased blast exposure for the Katy cultivar.

None of the remaining cultural blast control practices, used alone or in combination are as effective in controlling rice blast as timely applications of benomyl.

The rice plant is predisposed to blast development under dry-land conditions. This is extremely important in some cultivars. The effect of flood application compliments rather than replaces fungicide applications in blast control efforts. both are needed to control rice blast.

Straight head is a physiological problem where grain yield is greatly reduced or totally lost in fields having arsenic residues or a straight head history. The suggested control is to dry the field thoroughly prior to the time culm internodes began to elongate. As can be predicted this practice favors rice blast development and increases the level of inoculum in the field.

Excessive nitrogen favors rice blast and sheath blight development. Nitrogen is required for proper production and many of the new cultivars require high N levels to produce acceptable yield. If benomyl is lost growers will have the tendency to reduce nitrogen input and thus limit the overall yield potential of the crop.

Economic impacts to different sectors of the economy (producers, processors, consumers)

Producers will be directly impacted by loss of benomyl as a tool for rice blast control. Rough rice and milling yield reductions that result from blast and sheath blight diseases are incurred by the grower regardless of prior input costs.

Impact on imports and foreign competition

Reduced rough rice and milling yields with unchanging or increasing production costs will result in the need for a higher break-even cost for Arkansas rice growers. Thus growers will have to receive more for their product and will not be as competitive in foreign markets.

What are the yield benefits?

In general rough rice and milling yield responses occur when fungicides are applied for rice blast and sheath blight control.

Yield response in blast control applications of benomyl vary depending on rates/acre of benomyl used, the timing of each fungicide application, the disease level, and the yield potential of the field (See Appendix A). In locations with low to moderate blast infection satisfactory rough rice and milling yields are obtained without treatment. Substantial yield losses occur in those situations where blast inoculum levels were high and conditions were highly favorable for development. In the five tests reported in Appendix A an average yield response of 704 lbs/acre resulted from the two 0.5 lb/acre/applications. The average yield response to the 1.0 lb rate/acre/applications was 1528 lbs/acre over that to the untreated plots. Additional responses were observed with higher rates per application.

Impact on varietal, cultural and management practices

Growers select cultivars primarily on yield potential and market availability. The higher yielding cultivars tend to be more blast susceptible. Acceptance of the Katy cultivar has been slow because of the consistently lower yield potential. The increase in Katy acreage during 1992 was primarily due to the need to control rice blast. If benomyl is not available many growers would not be willing to accept the risk of substantial blast damage in the higher yielding cultivars and would tend to grow less susceptible cultivars.

Growers also tend to follow practices that limits disease exposure. Thus, they would reduce nitrogen applied to the crop and be less likely to drain for straight head if the option of fungicide treatment for rice blast was not available.

Comparative risks

Data on propiconazole and iprodione are filed with EPA for comparative risk analysis.

APPENDIX A

Table 1. Test results from fungicide applications to Newbonnet rice having severe blast prior to flood and throughout the growing season. 1987.

Treatment	AI[1] (lb/A)	NWBT[2] Yield (lb/A)	Blast Ratings[3] Late Heading % R.N.	Late Heading Visual	Harvest Visual
Untreated	-----	2863.3 C	.78	7.3	8.4
Benlate 50 DF	0.500	4131.7 AB	.27	3.0	7.3
Folatec 3.8FL	0.180	4123.3 AB	.44	5.3	7.7
Folatec 3.8FL	0.360	3461.2 BC	.46	4.5	8.0
Dithane 4EC	2.400	3450.8 BC	.33	3.8	7.6
C-2338 100EC	0.250	3524.4 BC	.61	6.0	8.1
HWG-1608 1.2EC	0.220	3438.1	.37	4.3	7.8
RH-3486 50WP+CS-7 Surf	1.000 + .125% vv	4929.3 A	.15	2.5	6.9
RH-7592 2FL + CS-7 Surf	0.250 + .125% vv	3874.6 BC	.46	4.8	7.3
Fongorene 50 WP	0.440	3771.4 BC	.38	3.8	7.6
PP-523 .5SC + 80/20 Surf	0.300 + .05% vv	3479.6 BC	.53	5.5	8.3
Top Cop + Sulfur	2 Qt/A	3874.5 BC	.30	3.3	7.1
Top Cop Tribasic	2 Qt/A	3565.8 BC	.37	3.8	7.7
		LSD .05 C.V.	989.2 17.4		

Means with the same letter are not statistically different at the 0.05 level.

[1] Two applications per treatment. Treatment 7-31-87 (late boot) and 8-10-87 (90% just headed).

[2] Newbonnet variety grown in grower field near Humphrey, Arkansas. Harvest 9-24-87.

[3] Blast data collected 8-24-87. The field stand was quite variable but most plants were in the late dough stage. Several heads were just starting to turn white (die) in the low disease plots. New lesions were still developing on younger panicles. % RN = percent rotten neck determined by the number infected heads per foot (3 points per plot) divided by average number plants per foot. Visual = overall rating of the plot on a 0 (none) to 9 (total loss) scale. Harvest rating on 9-21-87.

Table 2. Yield response to fungicides applied for rice blast control in infected Newbonnet rice. 1987.

			Blast Rating[3]	
Treatment	AI[1] (lb/A)	NWBT[2] Yield (lb/A)	%R.N.	Visual
Untreated	-----	2883.5	.55	8.3
Benlate 50DF	0.500	3283.0*	.09	2.5
Folatec 3.8FL	0.180	3621.7*	.38	6.3
Folatec 3.8FL	0.360	2335.3	.41	6.8
Dithane 4EC	2.400	3877.5*	.37	6.0
C-2338 100EC	0.250	2963.5*	.37	6.5
HWG-1608 1.2EC	0.220	3494.9*	.31	5.3
RH-3486 50WP +CS-7	1.000 +.125% vv	3908.6*	.19	3.3
RH-7592 2FL + CS-7	0.250 + .125% vv	3184.4*	.30	5.5
Fongorene 50Wp	0.440	3990.6*	.31	6.0
PP-523 .5SC + 80/20	0.300 + .05% vv	3240.7*	.39	6.5
Top Cop + Sulfur	2Qt	3307.4*	.29	5.5
Top Cop Tribasic	2 Qt	2762.5	.37	6.3
	LSD .05	934.0		
	C.V.	19.8		

(*) Yields are significantly different from the untreated check at 0.05 level.

1 Two applications per treatment. Applications were made at late boot (swollen boot on 7-24-87 and 90% heading (90% just emerged) on 8-1-87.)

2 Newbonnet variety grown in grower field near Stuttgart, Arkansas; Harvest 8-25-87.

3 Blast data collected 8-24-87; plants were near maturity with most starting to turn color. %RN = percent rotten neck as determined by the number infected heads per foot (3 points per plot) divided by average number plants per foot. Visual = overall rating of the plot on a 0 (none) to 9 (total loss) scale.

Table 3. Foliar fungicide applications to Newbonnet rice having substantial preflood blast but ending with moderate sheath blight and rice blast incidence. 1987.

		Application[1]							Harvest[3]	
Treatment	AI (lb/A)	VEB	MB	50%	100%	5D	10D	NWBT[2] Yield (lb/A)	S.B. Vis	R.N. Vis
Benlate 50WP	1.000	-	X	-	X	-	X	7591.1 AB	2.7	2.4
Benlate 50WP	1.000	-	-	-	X	X	-	7576.7 AB	3.5	2.4
Benlate 50WP	1.000	-	X	-	X	X	-	7533.3 AB	3.1	2.3
Benlate 50WP	1.000	-	X	-	-	X	-	7458.5 ABC	4.0	2.4
Benlate 50WP	1.000	-	X	-	X	-	-	7210.8 ABC	2.2	3.1
Benlate 50 WP	1.000	X	-	-	X	-	-	6724.5 BCDE	3.0	4.0
Benlate 50WP	1.000	-	-	X	-	X	-	6506.7 BCDE	3.8	2.7
Benlate 50WP	0.750	-	X	-	X	-	-	6867.8 BCD	2.9	3.3
Benlate 50WP	0.500	-	X	X	X	X	-	8084.4 A	3.5	2.4
Benlate.50WP	0.500	-	X	X	X	-	-	7239.5 ABC	2.2	2.9
Benlate 50WP+CS-7 Surf	0.500+.125%	-	X	-	X	-	-	7048.6 ABCD	2.9	3.3
Benlate 50WP+80/20 Surf	0.500+.125%	-	X	-	X	-	-	6518.6 BCDE	3.7	4.7
Benlate 50WP+PENETRATOR	0.500+.125%	-	X	-	X	-	-	6403.3 BCDEF	3.5	4.4
Benlate 50WP	0.500	-	X	-	X	-	-	6400.2 BCDEF	3.1	4.0
Benlate 50WP+AG-98 Surf	0.500+.125%	-	X	-	X	-	-	6276.2 CDEFG	2.6	2.2
Benlate 50WP+80/20 Surf	0.500+.25%	-	X	-	X	-	-	5971.5 DEFG	3.8	3.1
Benlate 50WP	0.250	-	X	-	X	-	-	5156.0 G	4.1	4.9
Folatec 3.8FL	0.180	-	X	X	X	X	-	5555.3 EFG	3.8	4.8
Top Cop + Sulfur	2 Qt	-	X	X	X	X	-	6735.2 BCDE	2.8	3.0
Untreated	-----	-	-	-	-	-	-	5296.4 FG	6.2	6.0
	LSD .05 C.V.							1023.9 10.8		

Means with the same letter are not statistically different at the 0.05 level.

[1] Applications indicate by X. Grower did not make additional fungicide applications. Applications were at very early boot (VEB) (panicle at 1/8-1/4 inch) on 7-15-87, at mid boot (panicle about 3 inches length) (chemicals premixed 17 hours prior to application) on 7-22-87, 30 heading; (30% of panicles just emerged) on 8-3-87; 90% heading on 8-7-87. 5 days (5D) after 90% heading on 8-12-87 and 10 days (10D) after 90% heading on 8-17-87.

[2] Newbonnet variety grown on grower field near Lonoke, Arkansas, Harvest 9-23-87.

[3] Panicle heads were turned over and just starting to mature on 8-22-87 with low levels of blast in the test plots and substantial blast just outside the test in the buffer area. Plot were visually rated on a 0 = none to 9 = maximum scale for blast and sheath blight 9-21-87. The buffer area would have rated approximately 7.5 at harvest.

Table 4. Yield response to fungicide application in Newbonnet having blast prior to first flood but with a low incidence of leaf blast and collar rot at beginning heading followed by moderate weather conditions during panicle emergence and filling. 1987.

		Application[1]								Late Heading Ratings	
Treatment	AI (lb/A)	VEB	EB	LB	40	100	6D	11D	NWBT[2] Yield (lb/A)	%RN	Visual
Benlate 50WP	1.000	-	-	X	-	-	X	-	8655.5 A	06	1.5
Benlate 50WP	1.000	-	-	-	X	-	X	-	8356.9 AB	07	2.5
Benlate 50WP	1.000	-	-	X	-	X	X	-	7997.4 ABC	05	2.0
Benlate 50WP	1.000	-	-	X	-	X	-	X	7956.7 ABC	10	2.0
Benlate 50WP	1.000	X	-	-	-	X	-	-	7695.1 ABCD	09	2.3
Benlate 50WP	1.000	-	-	X	-	X	-	-	7586.4 ABCDE	10	2.5
Benlate 50WP	1.000	-	-	-	-	X	X	-	6973.0 CDEF	22	3.5
Benlate 50WP	0.750	-	-	X	-	X	-	-	6370.6 EFG	13	3.0
Benlate 50WP	0.500	-	X	-	X	X	X	-	8722.8 A	07	2.0
Benlate 50WP	0.500	-	-	X	X	X	X	-	8436.8 A	05	2.0
Benlate 50WP	0.500	-	X	-	-	X	X	-	7994.6 ABC	12	2.5
Benlate 50WP	0.500	-	-	X	X	X	-	-	7082.6 CDE	10	2.5
Benlate 50WP	0.500	-	X	-	X	X	-	-	6615.5 DEF	15	2.8
Benlate 50WP	0.500	-	X	-	-	X	-	-	6495.3 EFG	24	4.0
Benlate 50WP	0.500	-	-	X	-	X	-	-	6426.5 EFG	23	3.5
Benlate 50WP+80/20 Surf	0.500 + 0.25VV	-	-	X	-	X	-	-	7187.6 BCDE	22	3.5
Benlate 50WP	0.250	-	-	X	-	X	-	-	5814.5 FGH	31	3.8
Folatec 3.8FL	0.180	-	-	X	X	X	X	-	5061.3 H	44	5.8
Top Cop + Sulfur	2 Qt	-	-	X	X	X	X	-	5347.0 GH	36	4.3
Untreated	——	-	-	-	-	-	-	-	4860.9 H	65	7.5
	LSD .05								1059.9		
	C.V.								12.1		

Means with the same letter are not statistically different at the 0.05 level.

[1] Applications at growth stage indicated by (X) character. No additional fungicide applied by grower. 1/4 inch panicle in the boot on 7-6-87. EB (early boot) on 7-14-87, LB (late boot, completely swelled boot with some heads starting to emerge) on 7-24-87, 40% headed (40% of panicles just emerged) on 7-27-87, 100% headed (100% just emerged) on 8-1-87, 6 D (6 days after 100% headed) on 8-7-87, and 11D (11days after 100% headed) on 8-12-87.

[2] Newbonnet variety in a grower field near Stuttgart, Arkansas.

[3] Plots were rated visually on a 0 = none to 9 = maximum scale as well as with a percent rotten neck (% RN) by count of infected panicles (average of 3 predetermined points per plot) when the panicles were in the waxy grain stage.

Table 5. Mean rough rice yield response to foliar fungicide application for rice blast control in Newbonnet rice. Grower field, Humphrey, Arkansas, 1988.

		Application[a] % HD						Blast		Milled Grain (%)
Treatment	kg ai/ha	BT	30	50	90	100	Yield[b] kg/ha	Visual[c] Ratings	Rotten[c] Neck (%)	Whole/Total
Untreated	—	.	.	.	.	.	3259.5 D	9.0	93.8	35/52
Benlate 50DF	0.56	+	.	.	+	.	4413.2 BC	6.5	48.6	46/59
Manex2 4FL	2.24	+	.	.	+	.	3670.9 CD	8.3	76.3	.
Manex2 4FL	2.24	+	+	+	+	+	5045.7 AB	4.8	30.6	48/61
Manex2 4FL tm	2.24	+	.	.	+	.	4359.4 BC	6.3	57.7	.
Benlate 50DF	0.28	+	.	.	+	.				
Manex2 4FL tm	2.24	+	+	+	+	+	5879.8 A	2.3	10.6	49/61
Benlate 50DF	0.28	+	+	+	+	+				
Top Cop with Sulfur	0.31 Cu. 3.47 S	+	.	.	+	.	4163.1 BCD	7.3	59.0	41/56
Top Cop with Sulfur	0.31 Cu. 3.47 S	+	+	+	+	+	4776.0 BC	3.8	29.2	44/58
Top Cop with Sulfur tm	0.31 Cu. 3.47 S	+	.	.	+	.	4364.1 BC	6.8	49.2	.
Benlate 50DF	0.50	+	.	.	+	.				
Top Cop with Sulfur tm	0.31 Cu. 3.47 S	+	+	+	+	+	4923.2 AB	2.5	18.8	46/59
Benlate 50DF	0.28	+	+	+	+	+	.			
Benlate 50DF	0.28	+	.	.	+	.	4048.0 BCD	7.5	78.3	.
Top Cop with Sulfur	0.62 Cu. 6.9 S	+	.	.	+	.	4470.6 BC	6.3	52.7	.
	LSD (0.5)						959.0			
	C.V.						15.0			

[a] BT application on 8-3-88, 30% HD on 8-6-88, 50% HD on 8-9-88, 90% HD on 8-12-88, and 100% HD on 8-15-88.

[b] Mean values followed by the same letters are not statistically different (P = 0.05) according to the Duncan's multiple range test.

[c] Visual disease ratings and rotten neck counts made on 9-1-88. Plots were harvested 9-14-88. Blast pressure was moderate (3-5 lesions sq yd) in the paddy and heavy on the levees (50-100% plants infected) at the boot growth stage.

Table 6. Mean rough rice yield response to selected copper and sulfur sources used in foliar fungicide applications for rice blast control in Newbonnet rice. Grower field. Humphrey, Arkansas, 1988.

		Application			Blast		
Treatment	kg ai/ha	BT	90%HD	Yield[b] kg/Ha	Visual[c] Ratings	Rotten[c] Neck (%)	Milled Grain (%) Whole/Total
Untreated	—	.	.	4505.5 AB	7.0	70.2	43/60
Top Cop with Sulfur	0.31 Cu. 3.47 S	+	+	4453.3 AB	5.8	58.4	.
That	3.47 S	+	+	4418.4 AB	6.5	70.2	41/58
Top Cop with Sulfur tm	0.31 Cu. 3.47 S	+	+	3938.2 B	6.8	61.3	.
That	1.74 S	+	+				
Top Cop with Sulfur	0.47 Cu. 5.21 S	+	+	4675.0 AB	5.5	44.4	46/61
Top Cop Tribasic tm	2.35 Cu	+	+	4565.3 AB	5.8	45.2	48/62
That	3.47 S	+	+				
Top Cop with Sulfur fb	0.31 Cu. 3.47 S	+	.	5300.2 A	4.5	41.7	46/60
Benlate	0.56	.	+				
Top Cop with Sulfur tm	0.31 Cu. 3.47 S	+	+	5115.6 A	4.0	29.8	47/61
Benlate	0.56	+	+				
Top Cop with Sulfur tm	0.31 Cu. 3.47 S	+	+	4459.3 AB	4.3	42.5	44/59
Benlate	0.28	+	+				
Benlate	0.56	+	+	4650.2 AB	4.8	42.5	.
	LSD (0.05)			863.0			
	C.V.			13.0			

[a] BT application on 8-3-88, HD application on 8-12-88.

[b] Mean values followed by the same letters are not statistically different (P = 0.05) according to the Duncan's multiple range test.

[c] Visual disease ratings and rotten neck counts made on 9-1-88. Plots were harvested 9-14-88. Blast pressure was moderate (3-5 lesions sq yd) in the paddy and heavy on the levees (50-100% plants infected) at the boot growth stage. Phytotoxicity was not observed at any time.

Table 7. Relative Response Over Five Grower Locations Following Late Boot and Head Exsertion Applications of Benomyl as a Control measure Following natural Infections of Blast in the Newbonnet Variety

Rate Form, Per Acre[1]	Location																	
	#1			#2			#3			#4			#5			Overall Average		
	RN[2]	Yield[3]	Milling[4]	RN	Yield	Milling	RN	Yield	Milling	RN	Yield	Milling	RN	Yield	Milling	RN	Yield	Milling
Untreated	--	5296	59/66	65	4861	44/62	46	2979	38/55	40	3348	37/61	67	2630	38/55	55	3829	44/60
0.5 lb	--	5156	60/67	31	5815	48/64	26	3935	48/62	24	4362	34/61	38	3397	40/57	30	4533	46/62
1.0 lb	--	6400	61/67	23	6427	48/64	21	4913	49/63	16	5044	38/63	33	4001	44/59	23	5357	48/63
1.5 lb	--	6858	62/67	13	6371	52/67	14	5196	50/63	17	5647	38/63	27	4229	43/58	18	5627	49/64
2.0 lb	--	7211	63/69	10	7586	--/--	--	----	--/--	27	4457	45/60	27	4457	45/60	--	----	--/--

[1] Rate of benomyl formulated as 50 percent wettable powder per acre per application.

[2] Percent rotten neck blast observed in plots at maturity.

[3] Yield in pounds per acre at 12 percent moisture.

[4] Milling yield expressed as percent whole grain over total grain.

APPENDIX II

LOUISIANA BENOMYL BENEFIT ASSESSMENT ON RICE

Benomyl Benefits Assessment on Rice in Louisiana

Donald E. Groth and Clayton A. Hollier

Economic Benefits of Benomyl to Growers, Processors and Consumers.

Rice is grown on an average of 550,000 acres each year in Louisiana. Gross farm income in 1992 was $196 million with $59 million added value giving a total value of the rice crop in Louisiana at $255 million. Under current economic constraints, rice farmers are dependant on good yield and high quality to make a profit. Rice diseases reduce these traits and cause significant economic hardship for rice farmers.

Louisiana provides a warm, humid climate favorable for endemic and epidemic development of rice diseases. The most important and common foliar diseases in Louisiana include sheath blight caused by the fungus *Thanatephorus cucumeris* (*Rhizoctonia solani*), blast caused by the fungus *Pyricularia grisea*, narrow brown leaf spot caused by the fungus *Sphaerulina oryzina* (*Cercospora janseana*), brown leaf spot caused by the fungus *Cochiobolus miyabeanus* and stem rot caused by the fungus *Magnaporthe salvinii* (*Sclerotium oryzae*). Under normal circumstances, sheath blight and blast are the primary diseases that become severe enough to justify spraying. However, occasionally, stem rot and narrow brown leaf spot are serious enough to warrant spraying in Louisiana. Often these and other minor diseases are reduced by fungicide applications directed toward sheath blight and blast management. Management of these minor diseases can contribute to the total yield and quality increase produced by fungicidal sprays.

Sheath blight is the most serious rice disease in Louisiana because of its extensive development each year and the significant yield loss it produces. Yield loss estimates are as high as 21% on susceptible varieties. This disease requires hot, humid conditions, high fertility levels and dense crop canopies to develop. Sheath blight has become a major disease in the last two decades because of the increase in 1) acreage of susceptible long-grain varieties, 2) use of soybeans in rotation with rice, 3) us of high rates of nitrogen fertilizer and 4)use of semi-dwarf varieties. These practices have led to the build-up of large populations of the fungal structures, called sclerotia, in soils. This disease develops most rapidly during the boot through grain filling stages of growth. Tilt, Rovral and Benlate fungicides have similar activity against sheath blight.

Blast is the second most important rice disease in the United States. Blast outbreaks are also dependant on climatic conditions, but they tend to be more sporadic in occurrence than sheath blight. Yield loss estimates for blast are higher than those of sheath blight when both diseases are present in a field. Losses as high as 90% have been experienced and losses of 50% are not uncommon. The rice blast fungus overwinters in rice straw, stubble and on seeds. The disease spreads rapidly in the field by means of airborne spores. During the vegetative stages of rice, from seeding to maximum tillering, elongated, spindle-shaped lesions with brown borders appear on the leaves. Severe infestations can lead to large areas of dead plants. Correct water management and application of a foliar fungicide are the most important management measures during the leaf blast phase. After heading,

brownish lesions can develop on the node at the base of the head, causing empty or partially filled florets or "blasting" followed by breaking over of the head to produce the "rotten-neck" symptom. Symptoms occur also on the nodes of the stem and at the collar of the flag-leaf blade. Preventive fungicidal sprays at boot and heading can suppress rotten-neck symptoms. Cultivars differ in their level of resistance, and selection of the most resistant cultivar is one of the most important management decisions a farmer makes. Of the recommended fungicides available to Louisiana rice farmers, only Benlate has activity against blast.

Ultimately, management of rice diseases will involve an integrated pest management system using a combination of disease resistance, pesticides, cultural practices, biological control and regulatory procedures. Management measures presently used include the use of resistant cultivars, fungicides and cultural practices that reduce disease and lower inoculum survival rate. Resistant, commercially acceptable cultivars are not always available for all rice diseases, and cultural management may be ineffective, impractical or against good production practices in some areas. The rice producer must then rely on the use of fungicides as the main line of defense.

Protection of a crop with a fungicide leads to higher yields (Table 1) and higher milling quality (Table 2) which translates into higher profits for rice producers and rice millers. The abundant supply of high quality rice ultimately leads to lower costs for the consumer.

Benomyl Usage in Louisiana

In a normal year 30% of the rice acreage is treated with a foliar fungicide. Of that, approximately half is treated with Benlate. In a severe blast year over 40% of the rice acreage is treated with a fungicide with Benlate applied to two-thirds of that acreage.

Benlate controls blast, narrow brown leaf spot, stem rot and suppresses sheath blight. The typical rate of Benlate is 0.5 lb a.i./A. this is normally applied once or twice during the season. The times of application are at boot and 80-90% heading. The normal time of year of application is during June and July. The crop is normally harvested approximately five (5) weeks later in August and September.

Although Tilt and Rovral also control sheath blight, Benlate is the only fungicide recommended that has activity against blast.

Concerning relative efficacy or the performance of alternate fungicides, when sheath blight was the primary disease present in a field there was no significant difference in yield performance among labeled fungicides based on 18 tests during 8 years (Table 1). When blast was the primary disease present, only Benlate increases yields significantly over the untreated check based on four (4) years of testing (Table 3).

Yield Benefits

Yield benefits from the use of Benlate are 679 lb/A from the first crop and 258 lb/A (Table 1) from the second or ratoon crop when sheath blight is the primary disease present.

There is also a three (3) percentage point increase in milling yield (Table 2). Milling increases are even higher when blast is present in the field. Net returns from Benlate are highest when milling is considered (Table 4).

Cultural and Varietal Impacts

No varieties are highly resistant to either sheath blight or blast. In addition no cultural practices will completely control both diseases although a few of these will lessen disease incidence and severity. These include: use of varieties with disease resistance in conjunction with good agronomic characteristics, avoiding late planting, avoiding excessive nitrogen fertilization, avoiding excessive seeding rates and maintaining an adequate flood (especially to reduce blast severity).

Loss of Benlate will cause most farmers to abandon many high yielding but susceptible varieties in favor of lower yielding resistant varieties.

With the loss of Furadan insecticide, the only control practice for rice water weevil is draining of the field and drying of ground. Although this reduces damage from rice water weevil it predisposes rice plants to infection by the blast fungus. This situation will increase the need for a blast fungicide for rice.

Comparative Risks of Likely Alternatives of Affected Fungicides

With the loss of Benlate, rice blast epidemics will go unchecked because there are no fungicide alternatives presently available. This puts our farmers at great risk of catastrophic losses due to the impact of this disease.

Table 1. Yield increases in first and second (ratoon) crops due primarily to sheath blight control by Benlate, Rovral and Tilt (either two 6 oz applications or one 10 oz application) applied to the first crop as compared to the untreated check. Data are the average of 8 years/18 tests first crop and 3 tests second crop conducted in Louisiana 1985-1992.

Treatment	Rate lb ai/A	Yield lb/A 1st Crop	Percent Increase	Yield lb/A 2nd Crop	Percent Increase
Unsprayed check	-	4841	-	1276	-
Benlate	0.5	5520	14	1534	20
Rovral	0.5	5450	13	1522	19
Tilt	0.17	5406	12	1740	36
Tilt	0.28	5509	14	1600	25
LSD p=0.05		375		276	

Table 2. Comparison of fungicide applications on milling yields of rice. Average of 5 years testing (1987-92), Rice Research Station, Crowley, LA.

Treatment	lb ai/A	% Head Rice (whole grains)	Total Milled Rice
Unsprayed Check	-	59.2	70.1
Benlate	0.5	62.4	70.9
Rovral	0.5	61.3	70.4
Tilt	0.17	60.6	70.5
Tilt	0.28	60.9	70.4
LSD p=0.05		0.9	0.5

Table 3. Yield increases due primarily to blast control by Benlate. Average of 4 tests (1989-90).

Treatment	Rate (lb ai/A)	Yield (lb/A)	Percent Increase
Unsprayed Check	-	3784	-
Benlate	0.5	4626	22
Rovral	No Activity		
Tilt	No Activity		

Table 4. Net returns for fungicide applications to rice including milling.

Treatment	Rate (lb ai/A)	First Crop	First and Second Crop
Benlate	0.5	$38.75	$63.43
Rovral	0.5	$17.86	$38.43
Tilt	0.17	$8.80	$39.28
Tilt	0.28	$28.56	$52.24

APPENDIX III

MISSISSIPPI BENOMYL BENEFIT ASSESSMENT ON RICE

ECONOMIC IMPACT OF BENOMYL USE ON MISSISSIPPI RICE

D. Caillavet

Currently, Mississippi grows approximately 250,000 acres of rice annually. The average annual yield is 5,600 pounds per acre and average annual production is 13,888,000 cwt. The five year average price received by Mississippi producers is $7.30 per cwt and the average value of production is $97,020,000 annually. It is estimated that, on average, Benomyl is used on approximately 20 percent of the acreage, or 50,000 acres, primarily for blast control.

Blast on rice in Mississippi is variable from year to year. During years of light pressure, yields may be reduced 10 percent on infected acres. However, during years of heavy pressure, yields may be reduced as much as 50 percent on infected acreage. Therefore, this analysis will examine the impact on two levels of pressure, light and heavy. In years with light pressure, a yield reduction of 560 pounds or 5.6 cwt is assumed. Yield reductions during heavy pressure is estimated to be 2,800 pounds or 28 cwt. Applying these yields to the estimated acreage treated results in a production loss of 280,000 to 1,400,000 cwt.

The lost production can be valued by applying the average price of $7.30 per cwt to each of the decreased production estimates. This results in a direct farm level loss of $2,044,000 to $10,220,000, depending on the level of infection.

The impact of this loss is not limited to the farmer alone. Since most of the rice produced in Mississippi is also processed in the state, the effect will be felt throughout the economy. The Mississippi Research and Development Center has developed an input-output model for the state, which includes multipliers for many sectors of the state's economy. Rice is included in the food and feed grains sector and has an output multiplier of 2.79 and an income multiplier of 1.78. The output multiplier measures the effect of changes in output (production) through the economy while the income multiplier measures the effect of changes in farm income on the local economy. Applying the multipliers to the value of lost production and farm income results in a total economic impact of $9,341,080 to $46,705,400. Combining this with the initial direct loss results in an overall economic impact due to the loss of Benomyl of $11,385,080 to $56,925,400.

ECONOMIC IMPACT OF BENOMYL

Component	Light Infection	Heavy Infection
Yield loss (cwt)	280,000	1,400,000
Value of production ($)	2,044,000	10,220,000
Economic output multiplier ($)	5,702,760	28,513,800
Economic income multiplier ($)	3,638,320	18,191,600
Total economic effect ($)	11,385,080	56,925,400

REFERENCES

Lee, Kuhn C. 1986. A study of the Mississippi input-output model. Mississippi Research and Development Center.

Mississippi Agricultural Statistics, 1988-1992.

APPENDIX IV

TEXAS BENOMYL BENEFIT ASSESSMENT ON RICE

BENOMYL BENEFITS ASSESSMENT ON RICE

Joseph P. Krausz
Professor
Department of Plant Pathology & Microbiology
118 Peterson Building
Texas A&M University
College Station, TX 77843-2132

ECONOMIC BENEFITS OF BENOMYL:

Between 1988 - 1992, approximately 2.79 million acres of rice was planted annually in the six rice-producing states of the United States producing a crop with an average annual farm value of about $1.1 billion. During the same period, an annual average of 357,500 acres of rice was planted in Texas, with an average yield of 5960 lb/A, and an average farm value of $153 million. Based on estimated production multipliers developed by Texas A&M University for agricultural commodities, rice production in Texas has an annual statewide economic impact of approximately $456 million.

Data from research tests suggest that rice diseases annually cause at least an average 12 - 15% loss in yield in Texas. With present production costs and price of rice, this average yield loss translates into an average 33 - 40% loss in potential profit due to rice diseases. Fungicides play an important role in limiting these losses. Benomyl is one of only four fungicides presently registered on rice in the United States. Benomyl has activity against several important rice diseases, including sheath blight (*Rhizoctonia solani*), rice blast (*Pyricularia oryzae*), narrow brown leaf spot (*Cercospora oryzae*), black sheath rot (*Gaeumannomyces graminis var. graminis*), and stem rot (*Sclerotium oryzae*). However, it is the <u>ONLY</u> product available that is effective against the devastating rice blast. Fortunately, rice blast epidemics historically occur only sporadically across much of the Texas rice belt, and the use of benomyl is usually less compared with alternative products when rice blast is not a problem. When and where rice blast is a threat, benomyl often is <u>essential</u> in preventing serious losses.

In the rice blast epidemic of 1991 in Texas, blast susceptible varieties sustained yield losses of up to 60% with grain of exceptionally poor quality remaining. In test results from 10 field locations in Texas during the blast epidemics of 1991 and 1992, benomyl gave an average yield increase of 19% by controlling blast. A survey of the quantity of benomyl applied on the Texas rice crop during these years indicates that 179,000 acres (53% of the total planted acres) were treated annually saving 2.63 million cwt of rough rice valued at approximately $14.7 million for each of 1991 and 1992. Grain quality or milling yields were also improved. In five (5) tests, the average increase in grain yield after milling was an additional 0.3% and the increase in whole (unbroken) grains was 1.3%. This further added to the value of the crop.

In relatively "non-blast" years, approximately 120,000 acres of rice (35% of the total planted acres) are treated with benomyl. Field tests in ten (10) locations over several years show an average yield increase of 9.7% with benomyl due to control of sheath blight, narrow brown leaf spot, black sheath rot, and stem rot. This saves the producers about $5.0 million each year.

BENOMYL USAGE IN TEXAS:

* Acres treated:
  1) In rice blast epidemic years: 179,000 acres
  2) In non-blast years: 120,000 acres

* Typical rate and time of application: 0.5 lb a.i./A from PD (panicle differentiation) to mid-boot and a second application at 80% heading.

* Diseases controlled:
  1) *Pyricularia oryzae* (rice blast)
  2) *Rhizoctonia solani* (sheath blight)
  3) *Cercospora oryzae* (narrow brown leaf spot)
  4) *Gaeumannomyces graminis var. graminis* (black sheath rot)
  5) *Sclerotium oryzae* (stem rot)

* Alternative chemical controls and relative efficacy:

Fungicide	Blast	Sheath Blight	NBLS	Black Sheath Rot	Stem Rot
Benlate (benomyl)	4	3	5	3	3
Tilt (propiconazole)	1	4	5	3	3
Rovral (iprodione)	0	3.5	2	1.5	0
Top-Cop (copper sulfate)	2	1	3	1	0

Control rating: 0 (no control) to 5 (excellent control).
NBLS = narrow brown leaf spot.

RELATIVE YIELD BENEFITS: (Average of 10 field tests 1990 - 1992)

1. AGAINST BLAST:

a) Benlate vs. no fungicide: + 19% yield increase

b) If Tilt replaces Benlate: - 11% yield decrease

c) If Rovral replaces Benlate: -11% yield decrease

2. AGAINST SHEATH BLIGHT:

a) Benlate vs. no fungicide: + 11% yield increase

b) If Tilt replaces Benlate: +3% increase over Benlate

c) If Rovral replaces Benlate: +2% increase over Benlate

CULTURAL AND VARIETAL IMPACTS:

The majority of Texas rice growers seek to follow cultural and management practices that tend to lessen disease incidence and severity and which are recommend by Texas A&M University. These practices include:

1) Timely planting
2) Avoiding excessive nitrogen fertilization
3) Avoiding excessive seeding rates
4) Maintaining an adequate flood
5) Use of varieties with disease resistance in conjunction with good agronomic characteristics

Little, if any, true resistance to sheath blight is available in most of the superior commercially available rice varieties. The cultivars Maybelle and Jackson seem to sustain less loss to sheath blight than most long grain varieties, and there combined acreage in Texas has increased to about 20%. However, they tend to yield less than the widely planted Gulfmont and Lemont cultivars and have poorer milling yields. Therefore, cultivar resistance to sheath blight is very limited in its impact on sheath blight control.

None of the widely grown long grain rice cultivars in Texas have high levels of resistance to the prevailing races (IC-17 and IB-49) of the rice blast pathogen (*Pyricularia oryzae*). Moderate levels of resistance (multigenic or rate-reducing resistance) exist in some of the widely planted cultivars such as Gulfmont and Lemont, and this resistance is very helpful in suppressing potential losses to rice blast. However, when environmental conditions remain favorable for blast development, this resistance is often inadequate to prevent serious losses.

In a recent fungicide test, a 20% yield increase was obtained with fungicide in the moderately resistant cultivar Gulfmont. With the present available level of resistance to rice blast, benomyl is still essential to avoid severe losses when blast becomes epidemic.

SUMMARY:

Benomyl serves a very important role in the rice production system in Texas and is especially noted as the only fungicide available that is effective against rice blast, a very serious and destructive disease. Although recommended cultural practices that help to suppress blast and moderately resistant varieties of rice are used extensively in Texas, blast still can cause serious losses when environmental conditions favorable for blast development occur and persist over extended periods of time. There presently is no alternative available in the United States that provides the protection from blast that benomyl provides.

Benomyl also serves as a control for other important diseases such as sheath blight, narrow brown leaf spot, black sheath rot, and stem rot. With sheath blight, the alternatives propiconazole (Tilt) and iprodione (Rovral) usually provide equal or slightly better control of this disease. However, Iprodione is significantly less effective against a number of the other important diseases, including narrow brown leaf spot, black sheath rot, and stem rot.

The loss of benomyl for use in the Texas rice industry would have a significant negative impact. Given the difficult economic constraints faced by rice farmers today, the loss of benomyl in the face of a serious rice blast epidemic similar to the epidemic of 1991, would undoubtedly permit such serious crop loss as to force many farmers out of the rice production.

APPENDIX F.

Biologic and Economic Assessment of Carbofuran

THE BIOLOGIC AND ECONOMIC ASSESSMENT OF

CARBOFURAN

A report of the Carbofuran Assessment Team
to the Special Review of Carbofuran

Submitted to the Environmental Protection
Agency on December 22, 1989

United States
Department of
Agriculture

In cooperation with

State Agricultural
Experiment Station

Cooperative Extension

Other State Agencies

U.S. Environmental
Protection Agency

Technical Bulletin
Number XXXX

Rice is grown in the United States in Arkansas, California, Florida, Louisiana, Mississippi, Missouri, and Texas with an average yearly rice production, based on information from 1980 through 1988, of approximately 142,000,000 cwt (see attached map). The annual value of U.S. rice production during this time period was roughly $1.2 billion. Using a multiplier factor of 3.2, the yearly impact of rice farming on the U.S. economy is approximately $4.4 billion. For comparison, the value of U.S. corn, soybean and winter wheat production in 1988 was roughly $13 billion, $12.8 billion and $323 million, respectively. On a global scale, U.S. rice acreage is only 0.9% of the world total, however, American rice farmers produce 1.7% of the world's rice. Most American rice (about 60%) is exported, often making the U.S. the largest exporter of rice in the world. Therefore, U.S. rice plays a crucial role in feeding the world when food stocks are low due to droughts, untimely flooding, or other catastrophic events.

Rice production in America is highly mechanized and sophisticated -- only seven man-hours are required to produce one acre of rice in the U.S. while more than 300 man- hours are needed in Asia and Africa. In the U.S. land is tilled with large tractors equipped with plows, discs, and harrows; divided into basins surrounded by levees to impound water and facilitate irrigation; and planted by air or large tractor drawn seeders. Rice is fertilized and treated by air with pesticides and harvested with self propelled combines. Active research and extension programs exist in all the rice producing states. These programs are funded by producer, industry, state, and federal contributions. Research is aimed at increasing yields, decreasing production inputs, improving quality, decreasing environmental problems associated with rice production, and improving marketing of the commodity.

A complex of insect pests attack U.S. rice from planting to post-harvest with the rice water weevil (RWW), *Lissorhoptrus oryzophilus* Kuschel, being a key pest. Adults invade rice fields in the spring and lay eggs in rice stems underwater. Eggs hatch and larvae move to roots where feeding results in delay in maturity and reduction in tillers and yield. The only insecticide labeled for use on rice to control the RWW in the United States is carbofuran. The remainder of this report constitutes a benefits assessment of carbofuran's use on rice in the U.S. The report will follow sections IV, V, and VI of the U.S.D.A.'s Outline for Pesticide Use Benefits Assessment.

IV. Specific Use Analyses

A. Current Registered Uses of the Pesticide by Site/Commodity

1. Registration summary

Carbofuran is applied as granular formulations to control the RWW. In the southern rice producing states (Arkansas, Louisiana, Mississippi, Missouri, and Texas), Furadan 3G and Furadan 5G are labeled and applied at 15 to 20 lb/ac (0.45-0.60 lb ai/ac) and 10 lb/ac (0.50 lb ai/ac), respectively, from one day before or within 21 days after permanent flooding (see

attached specimen label). In the south, most rice fields are dry seeded in the spring If there is sufficient soil moisture, the seeds germinate and rice seedlings emerge through the soil, however, when soil is too dry at planting, the field is flooded and drained which is called a "flush" irrigation. Occasionally, rainfall occurs at the proper time and substitutes for a flush. Additional flushes are applied when needed until rice is in the four to five leaf or actively tillering stage, approximately four weeks after seeding. At this time a flood is applied and maintained until rice nears maturity. This is called a "permanent" flood. In addition, some rice fields in the south are flooded then water seeded. These fields are drained for a brief or extended period before the permanent flood is applied, or are not drained making the initial flood a permanent one. These flooding methods are called "prolonged drainage", "pinpoint flood", and "continuous flood", respectively.

In California, Furadan 5G is labeled and applied at 10 lb/ac (0.50 lb ai/ac) prior to flooding and planting (see attached specimen label). Thus, California fields are water seeded with the initial flood maintained until near harvest.

Flooding practices affect RWW population dynamics and timing of carbofuran applications.

Although rice is grown in Florida, carbofuran is not labeled or used for RWW control because of minimal weevil problems and an alternative method of control which will be discussed in IVB.

2. Pest damage and infestation information

Planting and flooding date, rice variety and stand, water depth, fertility, edaphic factors, weather, method of irrigation and field design have a profound influence on RWW population dynamics and damage to rice. Obviously, these modifying factors vary within and among rice producing states; thus, yield losses due to the RWW will also vary within and among states. However, the RWW is the most ubiquitous insect pest of rice in the United States. Rice entomologists have not observed a single rice field that was not infested to some extent by the RWW. In fact, the aldrin seed treatment that was used prior to the registration of carbofuran was applied to 90% of the rice acreage in the southern rice producing states to control this pest.

Estimates of average yield reduction due to the RWW are based on field experiments with RWW protected and unprotected plots, and expert opinion of county extension agents, farm advisors, extension specialists, and university and USDA researchers familiar with rice production. These estimated average yield losses are assumed to occur given the withdrawal of carbofuran from use on rice acreage to be treated with this insecticide. However, entomologists from Louisiana and Texas estimate that in general twice as much rice acreage in these states should be treated for the RWW than is currently being treated. Sampling for the RWW is time consuming and requires some expertise; thus many producers do not sample and remain unaware of the extent of damage and opt not to treat fields which are infested. Also, some producers, in a mistaken effort to save money, do not use carbofuran even though RWW populations justify

an application. Finally, average yields by state are taken from carbofuran treated and untreated acreage. Thus, these yields should be lower relative to those from only carbofuran treated acreage. This results in a lower total production loss per state due to the RWW. For these reasons and the conservative figures of the surveyed experts, estimates of yield loss by the RWW are considered low.

Arkansas - Average yield loss on carbofuran treated rice acreage given withdrawal of the insecticide was estimated at 10%.

California - Average yield loss on carbofuran treated rice acreage given withdrawal of the insecticide was estimated at 33% (65-69). Untreated experimental plots have shown losses in yield ranging from 10 to 95% when compared to treated plots.

Louisiana - Average yield loss on carbofuran treated rice acreage given withdrawal of the insecticide was estimated at 10% An average of between 425-500 lb/ac decrease in yield was also estimated. However, in years of heavy infestation, 50% loss in yield can occur.

Mississippi - Average yield loss on carbofuran treated rice acreage given withdrawal of the insecticide was estimated at 900 lb/ac or about 18%.

Missouri - Average yield loss on carbofuran treated rice acreage given withdrawal of the insecticide was estimated at 15%.

Texas - Average yield loss on carbofuran treated rice acreage given withdrawal of the insecticide was estimated at 10%. Yield losses of the main crop have been reported as high as 30%. Unpublished data also show that RWW damage to the main crop can reduce yield of the ratoon crop which develops from main crop stubble. The ratoon crop is becoming increasingly important in Texas and Louisiana; in Texas approximately 40% of the main crop is ratooned.

The estimates show that average yield losses in California are about twice those of the majority of southern states. Major differences in rice culture, varieties, and RWW biology occur in California. Because rice emerges through a continuous flood in California, plants are attacked earlier and are weaker at time of attack. All RWWs are parthenogenetic females in California and show a distinct preference for rice growing near the levees and margins of fields. Most rice in the south does not receive a permanent flood until plants are actively tillering when they are more vigorous and less vulnerable to RWW attack. Both males and females occur and injury is more widespread across the fields; however, field margins still tend to harbor higher populations.

3. <u>Pest management recommendations</u>

Economic thresholds and recommendations have been established for the RWW and are published and utilized by producers and consultants throughout the rice growing states. The following is a state by state summary of the recommendations.

Arkansas - Two sampling methods can be used to estimate RWW activity. One is based on larval populations which are sampled

14 days after the onset of the permanent flood by removing soil cores (each core is 4 in. diam. by 3 in. deep) containing plants. A carbofuran treatment is economically justified if 10 or more larvae per core are recovered. A second method is based on adult feeding scars found on the youngest leaf of rice plants seven days after onset of the permanent flood. A sequential sampling plan is available which identifies levels of adult feeding activity and corresponding decisions to not treat or treat with carbofuran.

California - Recommendations are based on field history. Preventive preplant, preflood treatments of carbofuran should be applied to fields with chronic histories of damaging RWW populations. Only areas adjacent to field margins and levees should be treated. In fields with no history of RWW damage, postflood sampling for adult feeding scars is advised. Sampling should occur four to seven or 11 to 14 days after rice emergence through the water. For the earlier sampling period, if 20% of the plants have at least one adult feeding scar on the newest, unfurled leaf, then the field should be drained and treated. The threshold for the later sampling period is 10%.

Louisiana - Treatment decisions are based on adult feeding scars or larval densities. Rice should be sampled for feeding scars three to five days after the permanent flood in dry-seeded fields or an equal time after plants emerge through the water in water- seeded fields. Basically, fields should be treated if 50% or more of the sampled plants have a scar(s) on the newest, unfurled leaf. Larvae should be sampled seven to 10 days after the permanent flood in dry-seeded fields or an equal time after plants emerge through the water in water-seeded fields. If an average of five or more larvae are recovered per soil core, a carbofuran treatment is advised.

Mississippi - Larvae are sampled when adult feeding scars appear. A treatment is recommended when at least an average of one larva per core is recovered.

Missouri - Recommendations follow those developed for Arkansas.

Texas - Recommendations are similar to those of Louisiana.

4. <u>Actual on-farm use data</u>

All of the following estimates are based on information from 1983 through 1988.

Arkansas - An average of 1,067,500 ac was planted in rice and a mean of 3.7% (range 1-5%) of that acreage was treated annually with carbofuran. An FMC estimate of treated acreage was much higher for 1983 but the lower estimate was chosen to maintain a conservative approach to the study. California - An average of 390,167 ac was planted in rice and a mean of 30% (range 24.6-34.4%) of that acreage was treated annually with carbofuran.

Louisiana - An average of 456,667 ac was planted in rice and a mean of 30% of that acreage was treated annually with

carbofuran.

Mississippi - An average of 196,167 ac was planted in rice and a mean of 33% (range 16-50%) of that acreage was treated annually with carbofuran.

Missouri - An average of 71,167 ac was planted in rice and a mean of 5% of that acreage was treated annually with carbofuran.

Texas - An average of 336,333 ac was planted in rice and a mean of 30% of that acreage was treated annually with carbofuran.

For all states, only one application of carbofuran per growing season is allowed. In California, only 0.50 lb ai/ac can be applied, however, in the remaining states, 0.45-0.60 lb ai/ac can be applied. Some Louisiana and Texas rice producers who water seed use the high rate of carbofuran but the majority use 0.50 lb ai/ac.

5. Crop systems and practices

Arkansas - Carbofuran applications are generally made by air from one day before to 14 days after onset of the permanent flood. Rice is actively tillering at this time and approaching panicle initiation. Other crops grown in the rice producing counties include cotton, soybeans, grain sorghum, corn, catfish and baitfish. Rice and soybeans are often rotated in an effort to control red rice, a major weed pest of rice, and certain diseases. No problems involving drift of carbofuran into catfish and baitfish ponds have been reported.

California - Virtually all applications of carbofuran are made prior to flooding on dry soil at the time rice is planted. Most applications are made by air but some acreage is treated by ground. Almonds, plums, safflower, sunflowers, tomatoes, wheat, barley, walnuts, sugar beets, asparagus, cherries, peaches, cattle, kiwi, squash and melons are some of the other commodities produced in the rice growing counties. Despite this diversity, rice acreage is generally not planted to other crops.

Soil incorporation of carbofuran granules in the first two basins to receive water is required before flooding carbofuran treated fields. Also, producers strive to create a cloddy seed bed to minimize seedling drift. When carbofuran is applied to this type of seed bed, not all of the insecticide remains on the soil surface. These practices reduce non-target exposure to carbofuran.

Louisiana - Carbofuran is applied from one day before to 21 days after the onset of the permanent flood when rice is actively tillering. Most is applied by air between 10 and 14 days after the permanent flood in dry- seeded fields and at plant emergence through the water in water-seeded fields. Soybeans, crayfish, cattle, wheat, cotton, corn, and grain sorghum are the other major commodities grown in the rice producing parishes. Rice and soybeans are commonly rotated. About 100,000 ac of crayfish ponds occur in the rice producing counties. Most crayfish farms are double cropped with rice but the majority of this acreage is not treated with carbofuran.

Mississippi - Carbofuran is applied by air usually between one and two weeks after the onset of the permanent flood when rice is actively tillering. Soybeans, cotton, grain sorghum, and catfish also are grown in the rice producing counties with rice and soybeans commonly rotated. Rice and catfish farmers are acutely aware of the potential problem of carbofuran use near catfish ponds, thus, carbofuran is not applied to rice adjacent to these ponds and no problems have been reported.

Missouri - Most applications of carbofuran are made by air about 10 days after the onset of the permanent flood when rice is actively tillering. Other commodities grown in the rice producing counties are soybeans, corn, wheat, cotton, and catfish. Soybeans and rice are commonly rotated. No problems involving carbofuran use on rice and catfish production have been reported.

Texas - Carbofuran is applied by air usually seven to 14 days after the onset of the permanent flood when rice is actively tillering. Soybeans, cattle, sorghum, cotton, turf, corn, and crayfish are other commodities grown in the rice producing counties. Soybeans are normally rotated with rice to help control red rice and certain diseases.

In all states, water from carbofuran treated rice acreage is impounded to prevent movement into untreated areas (drainage ditches, canals, rivers, bayous, bays, marshes, and larger bodies of water). This practice probably also increases the effectiveness of the chemical treatment.

As described in IVA3, RWW control guidelines based on economic thresholds are available in all rice producing states where carbofuran is labeled. Use of these guidelines minimizes pesticide misuse and maximizes the effectiveness of the compound. Because the margin of profit in U.S. rice farming is becoming smaller, producers are becoming better crop managers and are employing extension and university recommendations to a greater extent than in the past. This trend should continue as U.S. rice farming becomes more technological and competitive with foreign rice suppliers.

6. Potential for pest resistance

Carbofuran has been labeled and applied to U.S. rice since 1970 (Furadan 3G registered January 23, 1970 in southern rice producing states; Furadan 5G registered August 7, 1972 in California) and to date no evidence of RWW resistance to carbofuran has been reported. However, in 1958 aldrin seed treatments were recommended for RWW control in Texas and by 1966 populations had developed resistance to this chlorinated hydrocarbon. RWW resistance to aldrin was reported as early as 1965 in Arkansas; thus, the RWW probably has the potential to become resistant to carbofuran. Since only female RWWs occur in California, resistance, if it develops, would be expected to occur sooner in the southern rice producing states which harbor more highly, genetically variable populations composed of males and females. On the other hand, the low number of RWW generations produced per year (one in California and Arkansas and two in the remaining rice producing states), the practice of applying one treatment of carbofuran annually, the relatively small amount of

total rice acreage treated with carbofuran, and the wide host range of the insect should discourage development of resistance.

B. Alternative management practices by site/commodity

Carbofuran is the only insecticide labeled on U.S. rice for RWW control. Entomologists in Arkansas, California, Louisiana, and Texas have evaluated the efficacy of pesticides for RWW control for many years. After the RWW developed resistance to aldrin, which was subsequently banned by EPA, an intensified screening program began resulting in the registration of carbofuran and bufencarb granules. The granular formulations were chosen to reduce the possibility of drift which had been a previous problem in rice fields. Bufencarb was dropped by the parent company because of reduced efficacy in controlling corn rootworms in the Midwest. The termination report of Regional Project S-162: Biology and Management of Insect Pests of Rice in the U.S. summarized U.S. rice entomologists' work on screening insecticides for RWW control with the following statement. "Over the duration of the project 43 insecticides were evaluated for rice water weevil control. The efficacy, rate, and timing of application was established for the insect growth regulators Dimilin and Alsystin, the synthetic pyrethriods Ambush, Pounce, Cymbush, Ammo, and PP-993, and the organophosphates Amaze, Counter and SC-0567 when used for rice water weevil control." For more detailed information, see the Annual Progress Reports of the Louisiana Agricultural Experiment Station Rice Research Station, Proceedings of the Rice Technical Working Group, and Insecticide and Acaricide Tests from 1981 to 1988. The granular formulations of carbofuran have been used as the standard of comparison in these efficacy tests with the result that Furadan 3G and 5G consistently gave as good or better control than the tested insecticides.

Because the RWW is aquatic in several stages, the management of water is a logical tool for manipulating its populations. In Florida, rice was grown on approximately 14,000 ac in 1988. The soil is very high in organic matter and rice producers commonly drain fields which releases nitrogen to the crop. In so doing, RWW populations are controlled and carbofuran is not needed. However, in the future, rice acreage will probably expand to include mineral soils which may require applications of insecticide for RWW control. In Arkansas, draining rice fields about two weeks after the onset of the permanent flood helps control straighthead (a physiological disorder of rice) and the RWW; however, carbofuran treatments aimed at the RWW are usually more economical because of reflooding costs, loss of nitrogen, weed reinfestation, and increased mosquito problems associated with draining. In all other rice producing states draining is not recommended as a tactic for controlling the RWW. During the summer months in the south, frequent rainfall occurs which prevents rice fields from drying sufficiently to reduce RWW populations. In California, summer rains seldom occur and would not hinder a draining program to control the RWW. However, herbicide residues in drain water are a serious legal problem in California. In addition, water delivery systems sophisticated enough to prevent excessive drying could be a problem in California where many rice fields are precision leveled resulting in very large basins. Draining is a potential management tool but there is a delicate balance between the benefits of RWW

population reduction and the disadvantages of plant water stress and competition with weeds.

Most stages of the RWW are concealed from attack by biological control agents. The egg is inserted in plant tissue underwater, and the larval and pupal stages are passed on rice roots surrounded by water-saturated soil. U.S. rice entomologists are not aware of natural parasites of the immature stages and predation of these stages is at most occasional and fortuitous. Recent tests with the nematodes Steinernema carpocapsae and Heterorhabditis sp. have shown promise when applied to moist soil as an inundative release for control of immature RWWs. Future work will emphasize timing of application and cost effectiveness. The adult RWW is subject to occasional but minimal predation in the aquatic habitat. Rodents consume some overwintering adults and a species of Beauveria fungus was recovered from weevils removed during winter from the crowns of perennial grass clumps. An undescribed species of mermithid nematode was found to parasitize RWW adults in Arkansas. The nematode caused adult mortality, infected primarily females, and decreased their fecundity. The maximum infection rate of adult weevils collected periodically in rice fields was 5.4%. To date, biological control agents do not offer a satisfactory substitute for existing chemical control.

The RWW overwinters at the bases of various weedy vegetation and plant debris on rice field levees and ditch banks. Some producers believe that destroying the overwintering sites will control the RWW. However, this would require a widespread cooperative grower effort and if implemented may not prove effective. A major drawback of the proposed control tactic would be elimination of cover for prime nesting areas for wildlife species such as pheasant, dove and resident ducks.

An ideal solution to the RWW problem would be to develop a resistant/tolerant variety. Efforts have been directed towards the plant resistance goal since 1963. In California, the sources of tolerance tend to be leafy, intermediate in height, and susceptible to lodging and blanking. Selections are being made to eliminate these undesirable traits, but given the release of a tolerant cultivar, the need for chemical control would still be required because of the relatively low levels of tolerance present in parental genotypes.

C. Economic and social impacts by site/commodity

The following production figures were taken from Agricultural Statistics U.S.D.A. Handbooks with the exception of some 1988 estimates which were provided by surveyed rice experts. Rough rice prices were from the same source and averages were by state for 1983, 1984, and 1985; average U.S. price for 1986 and 1987; and state estimates for 1988 which were provided by the same rice experts as cited above. The price base includes allowances for loans outstanding and purchases by the government valued at the average loan and purchase rate. Cost of carbofuran applications were based on estimates for 1989 provided by rice experts cited above and various aircraft applicators.

Arkansas - Average yield is 49.97 cwt/ac, average price of $6.75/cwt and total cost of carbofuran treatment is $15.00/ac.

California - Average yield is 72.26 cwt/ac, average price is $5.73/cwt, and total cost of carbofuran treatment is $13.42/ac.

Louisiana - Average yield is 43.40 cwt/ac, average price is $7.31/cwt, and total cost of carbofuran treatment is $12.00/ac.

Mississippi - Average yield is 49.17 cwt/ac, average price is $7.51/cwt, and total cost of carbofuran treatment is $12.00/ac.

Missouri - Average yield is 49.70 cwt/ac, average price is $7.46/cwt, and total cost of carbofuran treatment is $12.00/ac.

Texas - Average yield is 54.70 cwt/ac, average price is $7.63/cwt, and total cost of carbofuran treatment is $12.00/ac.

Table 1 summarizes the pertinent information needed for an economic assessment of the benefits of carbofuran to U.S. rice producers. Basically, for each state, yield loss/ac due to the RWW was converted to production loss in $/ac from which the cost/ac of a carbofuran treatment was subtracted. This value is considered the net benefit in $/ac from a carbofuran treatment. Finally, the net benefit/ac is multiplied by the number of carbofuran treated acres to arrive at the total net benefit for each state due to carbofuran.

Since the production estimates are based on six year averages and recent trends are towards increased acreage, yield and price, the total annual benefit for U.S. rice producers of $24.5 million due to carbofuran is obviously low. In addition, if government deficiency payments are taken into account, the economic benefits of carbofuran use are much greater because the target price of rice is employed in the calculations. The average target price for rice between 1983 and 1989 was $11.53/cwt. Using this figure, the following state by state net benefits of carbofuran use are:

State	Annual net benefits (\$\ac) of carbofuran	Annual total net benefits (\$/state of carbofuran)
AR	42.62	1,683,383
CA	261.52	30,610,942
LA	38.04	5,211,484
MO	73.96	263,176
MS	90.05	5,829,397
TX	51.07	5,152,958
Total		48,751,340

V. Exposure Considerations

The trigger for the special review of granular carbofuran is problems with avian toxicity. Rice fields provide excellent habitat for many species of vertebrates, including birds. In fact, many farmers lease their rice acreage for hunting purposes

during the late fall and winter when the land is idle. However, none of the surveyed rice researchers and extension specialists in the southern states was aware of any bird kills associated with the legal use of carbofuran on rice with the exception of a single report from Texas. In this study by Flickinger et al. three western sandpipers, one pectoral sandpiper and two redwinged blackbirds were found dead following application of carbofuran to five flooded rice fields on the Texas Gulf Coast. However, no mortality occurred when fulvous whistling ducks and mallard ducks were placed in cages in carbofuran treated rice fields. The authors of the report state: "The carbofuran levels in rice field waters from Furadan 3G applied at 19 kg of granules/ha (0.5 lb ai/ac) would not be expected to result in significant losses of either species" (fulvous whistling duck and mallard). They conclude that to minimize exposure of birds to 3G Furadan, the insecticide should only be used when insect density or damage is sufficiently high to warrant treatment. As mentioned before, economic thresholds for the RWW are available and used by U.S. rice producers and consultants. Basically, use of the thresholds forces producers to treat only when damaging RWW populations are present. This minimizes exposure of birds to carbofuran. The report further recommends that carbofuran should be applied to rice after May 15 to avoid the peak of bird migration. In the southern rice producing states, most carbofuran is applied one to two weeks after the onset of the permanent flood which generally occurs in May and June. In southwest Louisiana less than 5% of the carbofuran for RWW control is applied before May 15. Also, in the south, carbofuran is generally applied to flood water (not on exposed soil) so granules are not as accessible to birds. The granules sink into the mud substrate where the weevil larvae occur.

Waterfowl mortality in California rice fields treated with carbofuran was summarized in 1988 by Littrell. The bird kill was 630 from 1984 through 1988 with 105 deaths (104 ducks and one shorebird) occurring in the spring when Furadan 5G was applied for RWW control. The breakdown of deaths by years was 51, 31, 12, 3, and 0 from 1984 through 1988, respectively. The birds most likely contacted the granules through dabbling activities as fields were flooded following the preplant application of the insecticide. Littrell also reports bird mortality from carbofuran granules in the fall of 1985 (203 waterfowl and one northern barrier), fall of 1986 (218 waterfowl and four red-tailed hawks), and winter of 1988 (50 ducks). He did not identify the source of carbofuran causing mortality in the fall and winter and stated that literature did not support the theory that carbofuran persisted in rice fields for up to eight months from legal spring application.

Carbofuran has been misused with detrimental effects on birds. For instance, Flickinger et al. reported that Flowable Furadan was being used in Texas as a seed treatment to kill blackbirds depredating on the rice crop. Investigations conducted in 1984 to 1986 by the United States Fish and Wildlife Service resulted in the prosecution of parties involved in these illegal actions. American Rice Growers Cooperative in Raywood, Texas was fined $10,000 in a plea agreement involving 18 to 20 rice producers. Matagorda Farmers Cooperative in Bay City, Texas was fined $2,500 in a similar plea agreement. These were very strong warnings and have halted the illegal use of carbofuran in

Texas.

Recent fall and winter duck kills in California in 1988 may have been associated with the illegal use of carbofurar to kill crayfish (which burrow into levees) to prevent loss of water from basins flooded to attract waterfowl for hunting. Accidental spillage and failure to clean up may also be responsible for some of the reported bird kills in California. In one such instance a field with a temporary airstrip used in the application of agrichemicals was fallowed in 1987 and planted with rice in 1988. Carbofuran residues from spillage on the airstrip may have been responsible for subsequent bird kills in 1988.

Procedures to reduce or eliminate bird kills are in practice or being studied. As mentioned before, soil incorporation of carbofuran granules in the first two basins of treated fields is now required in California. This appears to be a successful tactic because of reduced resident duck kills in 1987 and failure to detect any kills in 1988 despite extensive air and ground surveys. A regulation to coat airstrips with asphalt to facilitate cleanup and discourage flooding is being considered. Littrell states: "Work continues to eliminate the deleterious effect of carbofuran. Cultural methods involving incorporation of granules into the soil prior to flooding has shown great promise with respect to lowering or eliminating the incidents of waterfowl loss. Use or modification of this application practice or development of other methods to prevent losses will continue until there is assurance that no waterfowl will be lost as a result of normal rice cultural practices using carbofuran. Enforcement activities will continue as a measure to prevent the possible illegal use of carbofuran during the fall months."

VI. Conclusion and Recommendations

Rice is grown in seven states in the U.S. on over 2.5 million acres which are perennially infested with the RWW -- the nation's most damaging insect pest of rice. **Data from replicated experiments and conservative estimates of experts attribute a national, annual rice production loss of 14% on RWW infested acreage.**

Carbofuran is the only insecticide labeled for control of the RWW, although during the past eight years over 40 insecticide treatments have been evaluated by State Experiment Station and USDA entomologists. Most treatments were not as consistently effective as carbofuran and the few that showed promise were dismissed by the parent companies for reasons other than problems of efficacy. **Depending on the price of rice received by producers, the annual benefit of carbofuran to U.S. rice farmers is estimated between $24.5 million and $48.7 million.**

Currently, no viable alternatives to carbofuran exist despite extensive research efforts in searching for other control tactics involving manipulation of irrigation practices and planting dates, development of resistant varieties, identification and impact of natural biological control agents, and determination of weak links in the life history of the RWW.

Carbofuran use in rice poses a minimal threat to non-target

species including birds. All carbofuran is applied in granular formulations which reduces the possibility of drift and allows more of the insecticide to reach the target site. In the southern rice producing states, most carbofuran is applied to flooded fields after migratory waterfowl have moved north. In California, recent regulations require incorporation of the granules in the first two water receiving basins of each treated field. In addition, all rice producing states have guidelines for control of the RWW based on economic thresholds which optimize the use of the insecticide. Many rice producers employ these recommendations in an effort to decrease production costs and increase yield.

Carbofuran has been applied illegally to kill blackbirds depredating on sprouting and ripening rice but prosecution of guilty parties has had the desired effect of eliminating this abuse. The insecticide has also been misused in California for control of crayfish which burrow into levees and cause drainage of basins. However, at present, investigations are being conducted by U.S. Fish and Wildlife Service to end this practice.

In conclusion, carbofuran is an excellent pest management tool for U.S. rice producers. When used according to label instructions, this insecticide is relatively safe to non-target wildlife species associated with the rice agroecosystem. The withdrawal of carbofuran would significantly reduce rice production and income to producers, since no viable alternative controls for the RWW are available. For these reasons, carbofuran should be retained for RWW control in U.S. rice production.

Table 1. Economic assessment of the benefits of carbofuran for control of the rice water weevil (RWW) on rice in the U.S.

(1)	State	AR	CA	LA	MO	MS	TX	TOTAL
(2)	Formulation	Furadan 3G	Furadan	Furadan 3G	Furadan 3G	Furadan 3G	Furadan 3G	
(3)	Avg rice ac planted	1,067,500	390,167	456,667	71,167	196,167	336,333	
(4)	Avg price rice ($/cwt)	6.75	5.73	7.31	7.46	7.51	7.63	
(5)	% acres treated	3.7	30	30	5	33	30	
(6)	Avg yield (cwt/ac)	49.97	72.26	43.40	49.70	49.17	54.70	
(7)	Avg a.i./ac	0.5	0.5	0.5	0.5	0.5	0.5	
(8)	No application/yr	1	1	1	1	1	1	
(9)	Total cost ($) of treatment/ac (includes insecticide plus application cost)	15.00	13.42	12.00	12.00	12.00	12.00	
(10)	Quality loss due to RWW	0	0	0	0	0	0	
(11)	Avg yield loss (%) due to RWW	10	33	10	15	13	10	
(12)	Net benefit ($/ac) from carbofuran[a]	18.73	123.22	19.73	43.61	54.47	29.74	
(13)	Total net benefit ($)/state from carbofuran[b]	739,788	14,422,913	2,703,012	155,180	3,526,121	3,000,763	24,547,777

[a] Row 12 was derived by: [(6) x (11)/100 x (4)] – (9).

[b] Row 13 was derived by: (12) x (3) x (5)/100.

Furadan 15G (carbofuran) is registered for thrips and leafhopper control on peanuts at up to 1.0 lb. ai/acre. For control of Southern Corn Rootworm (SCR) in the southeastern states, Furadan 15G is registered for use at 1.0 to 2.0 lb. ai/acre banded over the row at pegging (60-90 days after planting).

Furadan is labeled up to 4.95 lb. ai/acre for nematode control to be applied in an 18 inch band prior to planting and incorporated to a depth of 3 inches.

Furadan 15G is applied for thrips control on 18,468 acres of the 1.57 million acres of peanuts planted in the United States. Numerous studies from all peanut areas of the United States indicate that thrips control seldom results in increased yield. Therefore, no quality or yield adjustment can be attributed to thrips damage when any of these insecticides are lost. Furadan's lack of effectiveness in controlling thrips appears to be the primary reason for its relatively small usage compared to the other insecticides.

Southern Corn Rootworm is a soil insect that damages peanuts by feeding on pegs or pods. Significant population of SCR are found in Georgia, Virginia, North Carolina, and South Carolina. Only occasionally are SCR a problem in Alabama or Florida.

Although most research data show carbofuran efficacy on SCR in peanuts to be similar to the alternatives, Furadan 15G is only used on about 31 thousand acres of the 293 thousand acres treated for SCR. No loss of benefit can be shown when carbofuran alternatives are used.

Seven and one-half percent (117,750 acres) of the United States peanut acreage is treated with carbofuran ostensibly as a nematicide (i.e. banded at high rates). It is possible, however, that some of the reported insecticide treated acres are redundant with nematicide treated acres reported, since some growers use this material for both purposes in one application. Only one state reported a quality change (Oklahoma) and one state reported a yield change (Virginia) resulting from the loss of carbofuran. In general, there are currently adequate alternative materials available and little economic impact would result from the loss of carbofuran as a nematicide.

Although the committee is hesitant to see an available granular pesticide alternative removed, the small amount used and marginal benefit indicates that the loss of carbofuran will not burden peanut producers.

APPENDIX G.

Economic Assessment

Figure 1. Projected U.S. Rice Production for 1996-2005, million hundredweight.

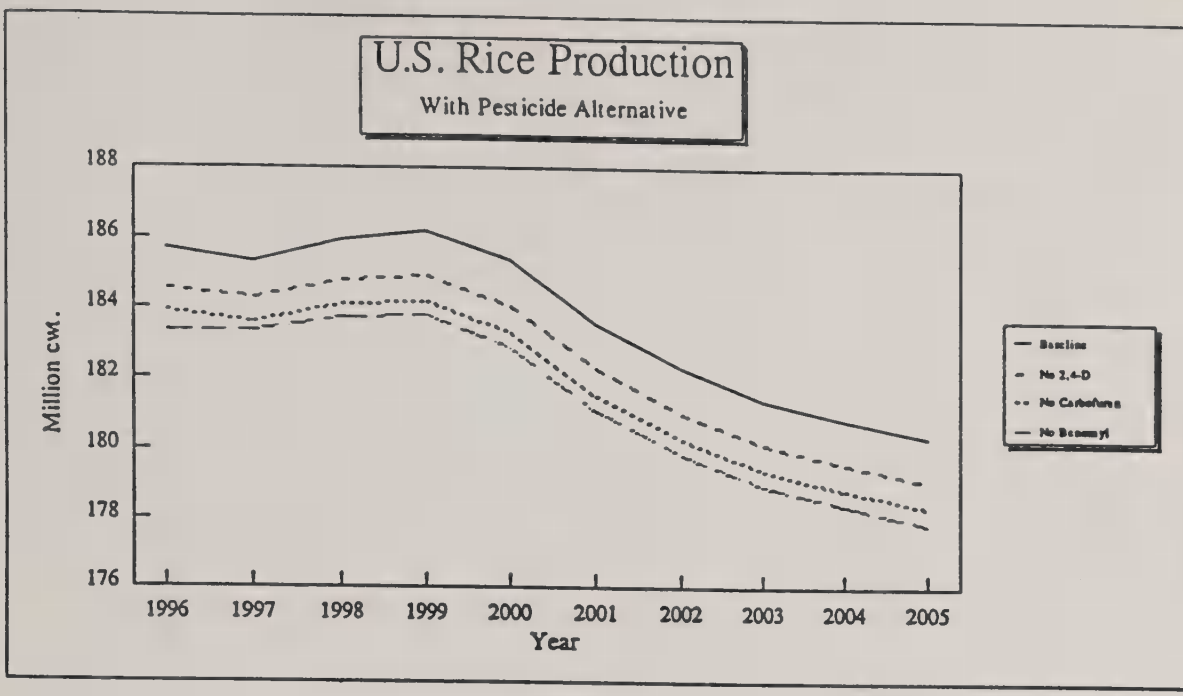


Figure 2. Projected U.S. Rice Production for 1996-2005, million hundredweight.

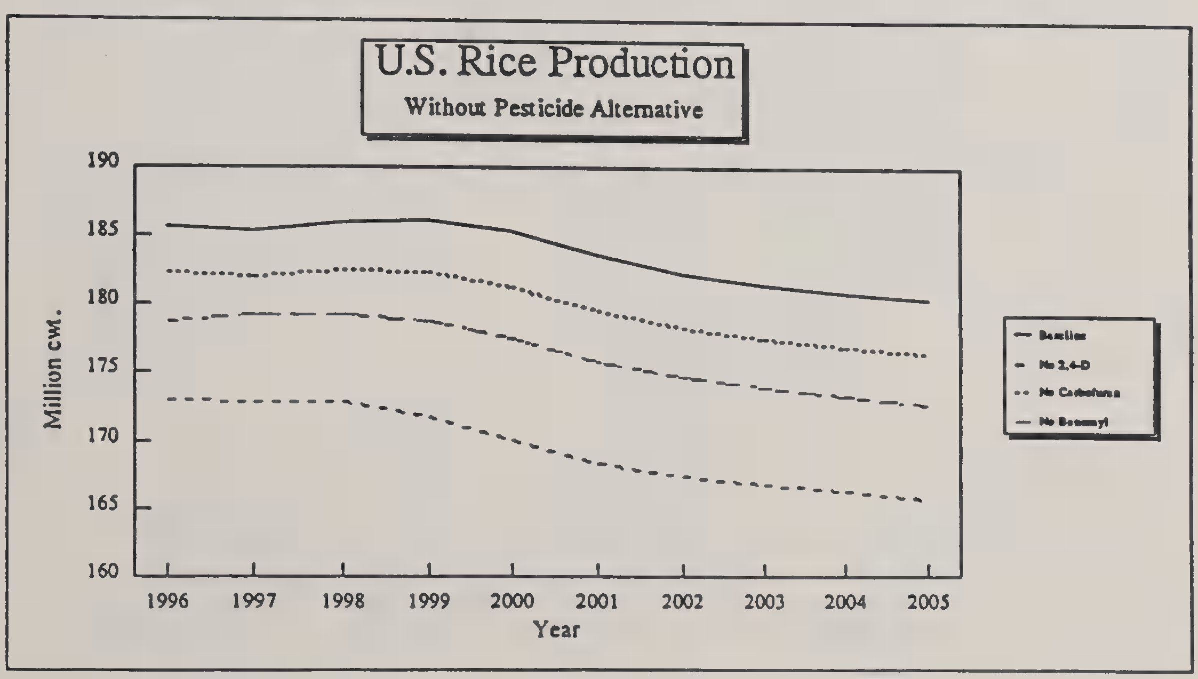


Figure 3. Projected U.S. Rice Farm Price for 1996-2005, dollars per hundredweight.

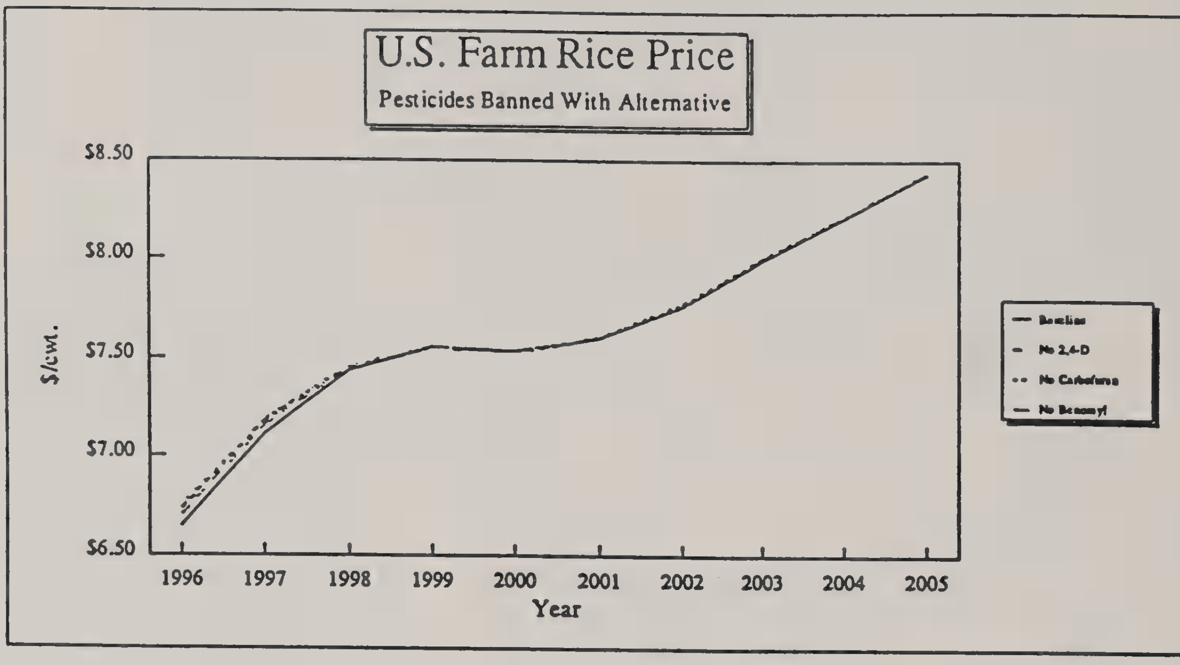


Figure 4. Projected U.S. Rice Farm Price for 1996-2005, dollars per hundredweight.

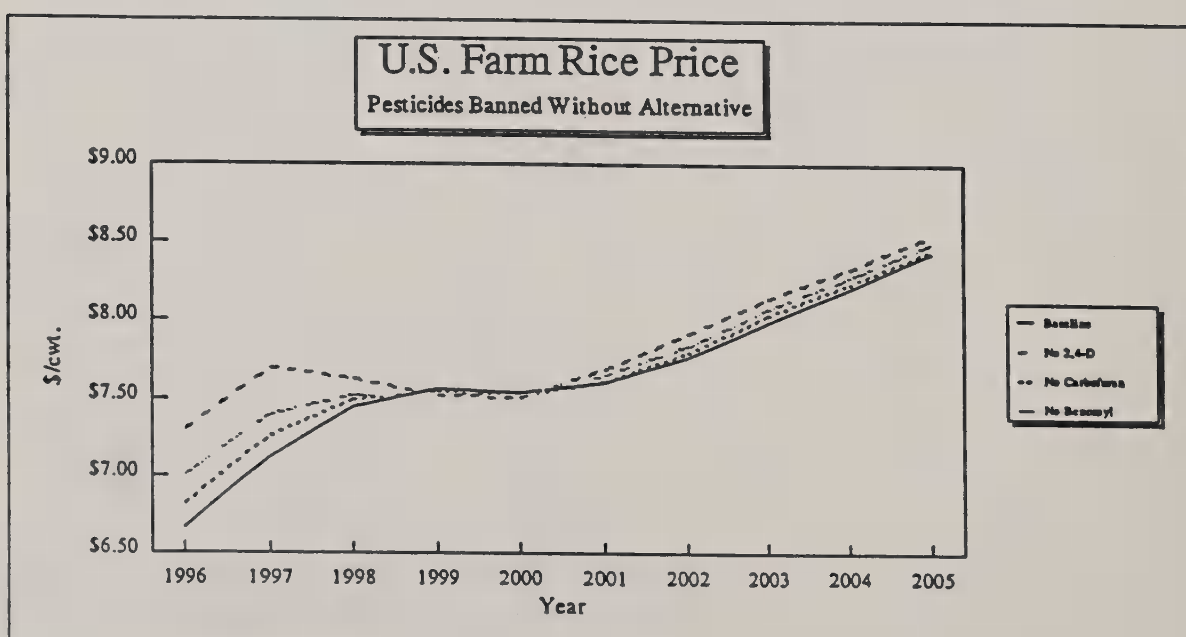


Figure 5. Projected U.S. Rice Retail Price for 1996-2005, dollars per hundredweight.

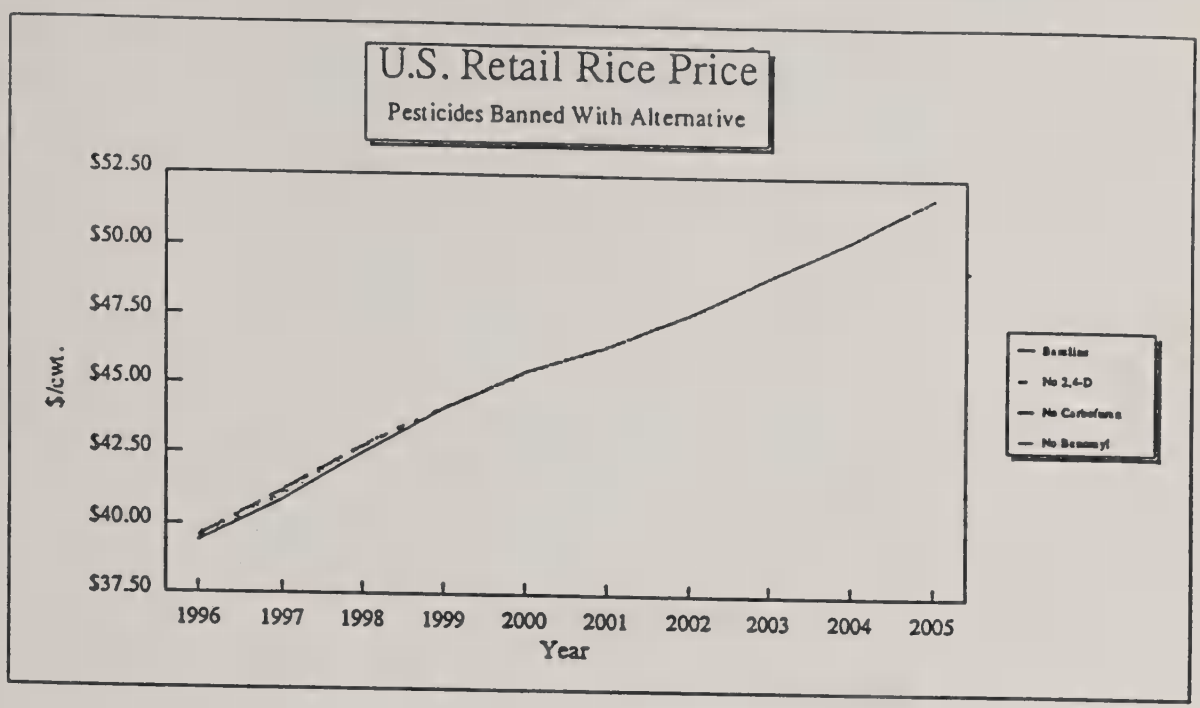


Figure 6. Projected U.S. Rice Retail Price for 1996-2005, dollars per hundredweight.

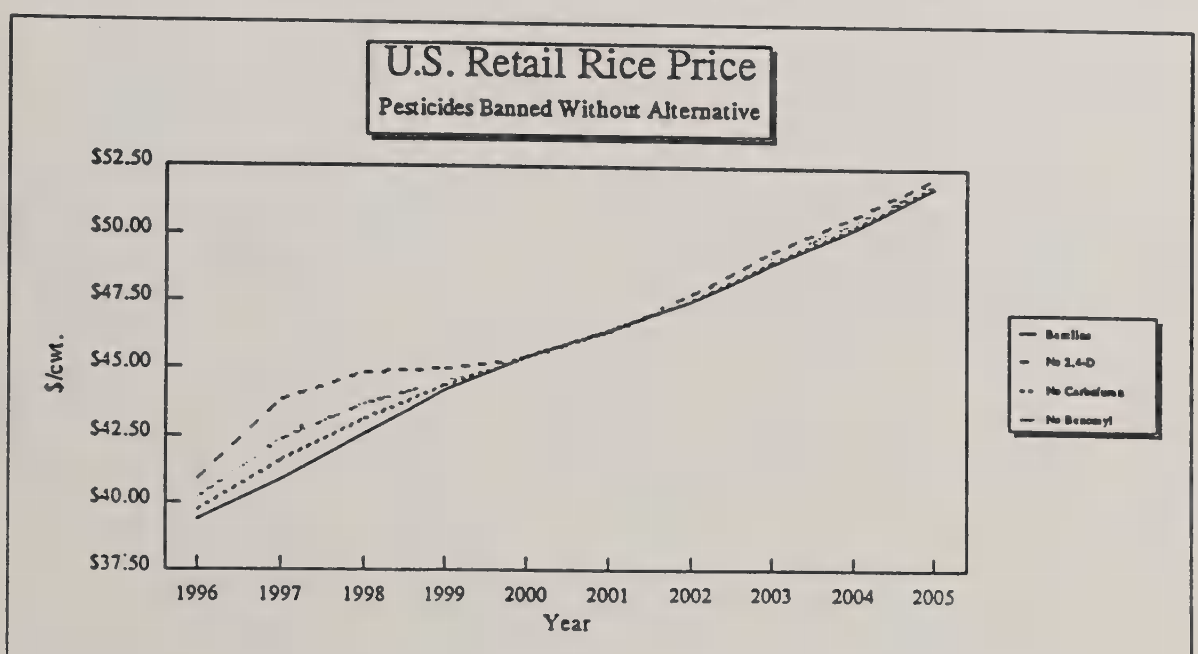


Figure 7. Projected Returns Above Variable Costs for U.S. Rice for 1996-2005, dollars per acre.

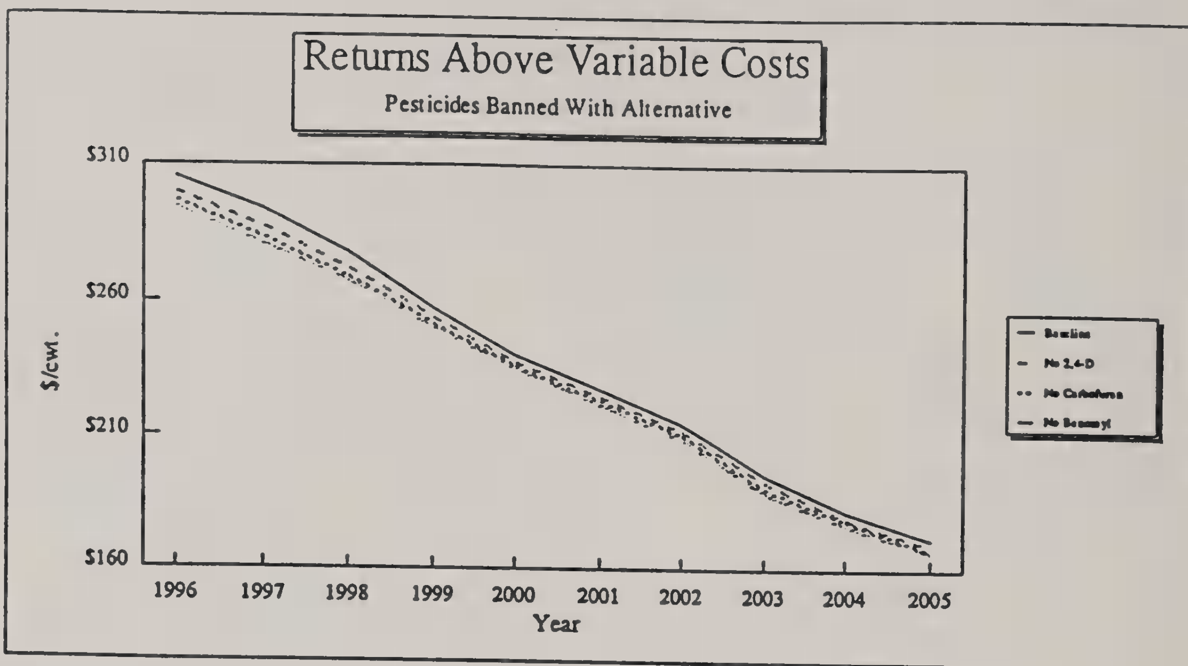
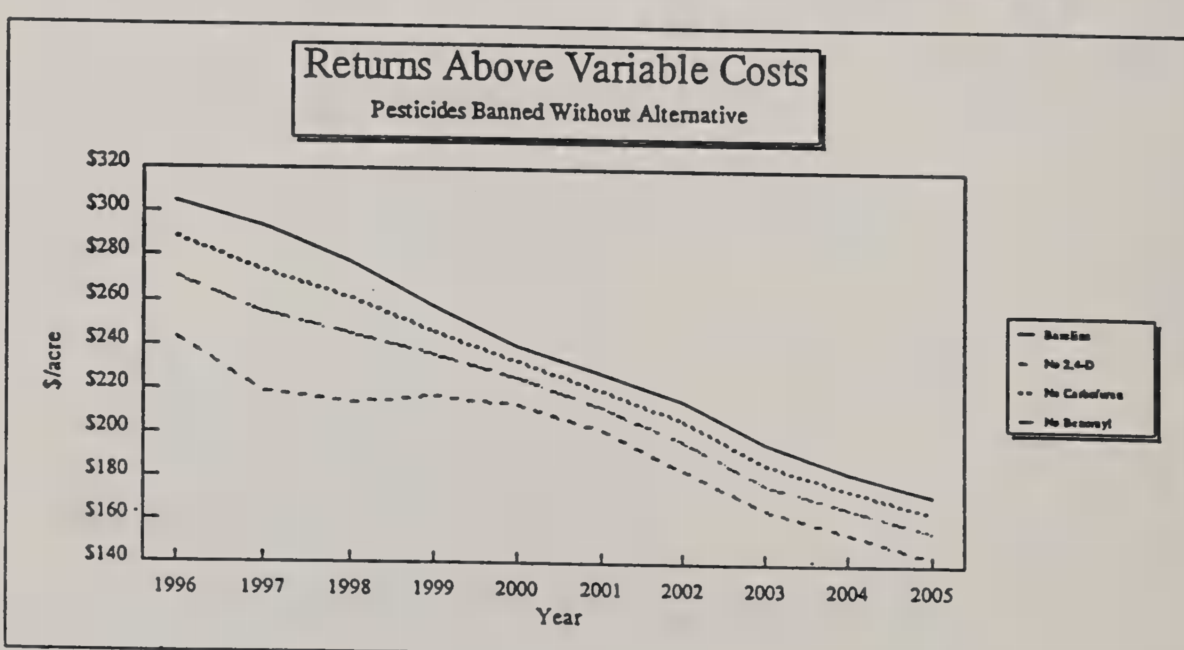


Figure 8. Projected Returns Above Variable Costs for U.S. Rice for 1996-2005, dollars per acre.



U.S. RICE

2,4-D WITH ALTERNATIVE

US RICE SUPPLY AND UTILIZATION

VARIABLE/YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
HARVESTED AREA (1,000 Acres)													
Baseline	2833.0	3316.0	3100.0	3214.3	3188.8	3182.3	3173.0	3146.3	3103.2	3068.3	3040.6	3018.8	2997.4
Scenario	2833.0	3316.0	3100.0	3214.3	3187.9	3180.4	3169.0	3141.0	3097.8	3063.3	3035.9	3014.1	2992.5
Change	0.0	0.0	0.0	0.0	-0.9	-1.9	-4.0	-5.3	-5.4	-5.0	-4.7	-4.7	-4.8
% Change	0.0%	0.0%	0.0%	0.0%	-0.0%	-0.1%	-0.1%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
SUPPLY (Million Cwt)													
Baseline	202.4	231.6	222.6	232.1	233.3	232.5	232.3	233.2	234.5	235.3	235.6	235.9	236.0
Scenario	202.4	231.6	222.6	231.0	231.9	231.1	231.1	232.0	233.2	234.0	234.3	234.5	234.7
Change	0.0	0.0	0.0	-1.1	-1.5	-1.4	-1.2	-1.2	-1.3	-1.3	-1.3	-1.3	-1.3
% Change	0.0%	0.0%	0.0%	-0.5%	-0.6%	-0.6%	-0.5%	-0.5%	-0.5%	-0.6%	-0.6%	-0.6%	-0.6%
PRODUCTION (Million Cwt)													
Baseline	156.1	197.8	178.4	185.7	185.3	185.9	186.2	185.4	183.6	182.3	181.4	180.9	180.3
Scenario	156.1	197.8	178.4	184.6	184.3	184.8	185.0	184.1	182.3	181.1	180.2	179.6	179.1
Change	0.0	0.0	0.0	-1.1	-1.0	-1.1	-1.2	-1.3	-1.3	-1.3	-1.2	-1.2	-1.2
% Change	0.0%	0.0%	0.0%	-0.6%	-0.6%	-0.6%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%
IMPORTS (Million Cwt)													
Baseline	6.9	8.0	8.9	10.7	11.7	12.4	12.7	12.9	13.3	13.9	14.5	15.1	15.6
Scenario	6.9	8.0	8.9	10.7	11.6	12.3	12.7	12.9	13.3	13.9	14.5	15.1	15.6
Change	0.0	0.0	0.0	0.0	-0.0	-0.1	-0.0	-0.0	0.0	0.0	0.0	0.0	0.0
% Change	0.0%	0.0%	0.0%	0.2%	-0.3%	-0.5%	-0.3%	-0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
DOMESTIC USE (Million Cwt)													
Baseline	101.5	104.2	104.6	106.7	108.7	110.5	112.1	113.6	115.0	116.4	117.9	119.3	120.7
Scenario	101.5	104.2	104.6	106.7	108.7	110.4	112.1	113.6	115.0	116.4	117.8	119.3	120.7
Change	-0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
% Change	-0.0%	0.0%	0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%
Food Use (Million Cwt)													
Baseline	71.2	74.0	76.1	78.0	79.7	81.3	82.9	84.3	85.7	87.1	88.5	89.9	91.2
Scenario	71.2	74.0	76.1	78.0	79.7	81.3	82.8	84.3	85.7	87.1	88.5	89.8	91.2
Change	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
% Change	0.0%	0.0%	0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%
Other Uses (Million Cwt)													
Baseline	19.3	19.2	19.5	19.8	20.0	20.1	20.2	20.3	20.3	20.3	20.4	20.4	20.5
Scenario	19.3	19.2	19.5	19.8	20.0	20.1	20.2	20.3	20.3	20.3	20.4	20.4	20.5
Change	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
% Change	0.0%	0.0%	0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%
EXPORTS (Million Cwt)													
Baseline	75.2	92.0	82.3	89.0	90.5	88.6	85.3	82.1	80.3	79.2	77.8	76.5	74.9
Scenario	75.2	92.0	82.3	88.3	89.3	87.2	84.0	80.9	79.1	78.0	76.6	75.3	73.7
Change	0.0	0.0	0.0	-0.6	-1.2	-1.4	-1.3	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2
% Change	0.0%	0.0%	0.0%	-0.7%	-1.3%	-1.6%	-1.5%	-1.5%	-1.5%	-1.5%	-1.6%	-1.6%	-1.6%
TOTAL USE (Million Cwt)													
Baseline	176.7	196.2	186.9	195.7	199.2	199.1	197.4	195.7	195.4	195.6	195.7	195.8	195.6
Scenario	176.7	196.2	186.9	195.1	198.0	197.6	196.1	194.4	194.2	194.4	194.4	194.5	194.4
Change	0.0	0.0	0.0	-0.7	-1.2	-1.4	-1.3	-1.2	-1.2	-1.2	-1.2	-1.3	-1.2
% Change	0.0%	0.0%	0.0%	-0.3%	-0.6%	-0.7%	-0.7%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%
ENDING STOCKS (Million Cwt)													
Baseline	25.8	35.4	35.7	36.3	34.1	33.4	34.9	37.6	39.1	39.7	39.9	40.1	40.4
Scenario	25.8	35.4	35.7	35.9	33.9	33.4	35.0	37.6	39.1	39.6	39.8	40.0	40.3
Change	0.0	0.0	0.0	-0.4	-0.2	0.0	0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.1
% Change	0.0%	0.0%	0.0%	-1.1%	-0.7%	0.1%	0.3%	0.1%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
FARM PRICE (Dollars per Cwt)													
Baseline	8.09	6.68	6.48	6.66	7.11	7.44	7.56	7.53	7.60	7.76	8.00	8.21	8.43
Scenario	8.09	6.68	6.48	6.71	7.16	7.45	7.55	7.53	7.60	7.77	8.01	8.22	8.44
Change	0.00	0.00	0.00	0.05	0.05	0.02	-0.00	-0.00	0.01	0.01	0.01	0.01	0.01
% Change	0.0%	0.0%	0.0%	0.8%	0.7%	0.2%	-0.0%	-0.0%	0.1%	0.2%	0.2%	0.1%	0.1%
YIELD (pounds/acre)													
Baseline	5510	5964	5753	5777	5812	5842	5869	5893	5917	5942	5966	5991	6016
Scenario	5510	5964	5753	5743	5782	5812	5837	5861	5886	5910	5935	5959	5984
Change	0.00	0.00	0.00	-33.50	-30.59	-30.83	-31.21	-31.48	-31.59	-31.65	-31.73	-31.85	-31.96
% Change	0.0%	0.0%	0.0%	-0.6%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%

AGRM 1995 WORLD AND U.S. RICE PRICE PROJECTIONS
2,4-D WITH ALTERNATIVE

PRICE/ YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
THAI PRICE (FOB), US$/mt													
Baseline	271.00	280.00	254.00	251.39	262.90	273.10	283.55	290.40	295.30	299.60	307.80	312.80	321.90
Scenario	271.00	280.00	254.00	253.95	266.50	275.70	284.60	290.65	295.50	299.95	308.30	313.30	322.30
Change	0.00	0.00	0.00	2.56	3.60	2.60	1.05	0.25	0.20	0.35	0.50	0.50	0.40
% Change	0.00%	0.00%	0.00%	1.02%	1.37%	0.95%	0.37%	0.09%	0.07%	0.12%	0.16%	0.16%	0.12%
U.S. EXPORT PRICE (FOB), US$/mt													
Baseline	457.45	319.67	333.42	335.80	349.77	362.77	376.24	387.09	396.59	405.78	418.21	427.96	441.21
Scenario	457.45	319.67	333.42	337.87	352.67	364.86	377.09	387.29	396.76	406.06	418.62	428.36	441.53
Change	0.00	0.00	0.00	2.06	2.90	2.09	0.85	0.20	0.16	0.28	0.40	0.40	0.32
% Change	0.00%	0.00%	0.00%	0.61%	0.83%	0.58%	0.22%	0.05%	0.04%	0.07%	0.10%	0.09%	0.07%
U.S. EXPORT PRICE (FOB), $/cwt milled													
Baseline	20.75	14.50	15.12	15.23	15.87	16.46	17.07	17.56	17.99	18.41	18.97	19.41	20.01
Scenario	20.75	14.50	15.12	15.33	16.00	16.55	17.10	17.57	18.00	18.42	18.99	19.43	20.03
Change	0.00	0.00	0.00	0.09	0.13	0.09	0.04	0.01	0.01	0.01	0.02	0.02	0.01
% Change	0.00%	0.00%	0.00%	0.61%	0.83%	0.58%	0.22%	0.05%	0.04%	0.07%	0.10%	0.09%	0.07%
U.S. FARM PRICE, $/cwt rough													
Baseline	8.09	6.68	6.48	6.66	7.11	7.44	7.56	7.53	7.60	7.76	8.00	8.21	8.43
Scenario	8.09	6.68	6.48	6.71	7.16	7.45	7.55	7.53	7.60	7.77	8.01	8.22	8.44
Change	0.00	0.00	0.00	0.05	0.05	0.02	-0.00	-0.00	0.01	0.01	0.01	0.01	0.01
% Change	0.00%	0.00%	0.00%	0.82%	0.68%	0.22%	-0.03%	-0.01%	0.11%	0.17%	0.17%	0.15%	0.13%
U.S. BREWERS PRICE, $/cwt milled													
Baseline	7.41	8.08	8.18	8.31	8.54	8.86	9.19	9.50	9.78	10.07	10.38	10.72	11.06
Scenario	7.41	8.08	8.18	8.31	8.55	8.87	9.20	9.50	9.78	10.07	10.39	10.72	11.07
Change	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
% Change	0.00%	0.00%	0.00%	0.00%	0.12%	0.15%	0.09%	0.03%	0.01%	0.02%	0.03%	0.03%	0.03%
U.S. RETAIL PRICE, cents/lb milled													
Baseline	45.59	41.55	39.09	39.35	40.82	42.56	44.20	45.44	46.44	47.54	48.97	50.29	51.84
Scenario	45.59	41.55	39.09	39.48	41.07	42.75	44.27	45.45	46.45	47.57	49.01	50.33	51.87
Change	0.00	0.00	0.00	0.13	0.25	0.19	0.07	0.01	0.01	0.03	0.04	0.04	0.04
% Change	0.00%	0.00%	0.00%	0.34%	0.62%	0.45%	0.17%	0.02%	0.02%	0.06%	0.08%	0.08%	0.07%

AGRM 1995 U.S. FARM INCOME IMPACT PROJECTIONS
2,4-D WITH ALTERNATIVE

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Production Market Value (million $)													
Baseline	1263	1321	1155	1236	1318	1383	1407	1396	1395	1415	1451	1484	1520
Scenario	1263	1321	1155	1239	1320	1378	1397	1386	1386	1407	1443	1476	1512
Change	0	0	0	3	2	-5	-10	-10	-8	-7	-8	-8	-9
% Change	0.0%	0.0%	0.0%	0.2%	0.1%	-0.4%	-0.7%	-0.7%	-0.6%	-0.5%	-0.5%	-0.5%	-0.6%
Government Program Cost (million $)													
Baseline	785	757	817	856	740	648	588	564	534	491	421	377	342
Scenario	785	757	817	836	718	635	583	562	531	487	417	375	340
Change	0	0	0	-20	-23	-14	-4	-1	-2	-4	-4	-2	-2
% Change	0.0%	0.0%	0.0%	-2.3%	-3.1%	-2.1%	-0.8%	-0.2%	-0.5%	-0.8%	-1.0%	-0.5%	-0.5%
Total Income (million $)													
Baseline	2048	2078	1972	2092	2058	2031	1995	1960	1929	1906	1872	1861	1862
Scenario	2048	2078	1972	2075	2037	2013	1981	1949	1918	1894	1860	1851	1852
Change	0	0	0	-17	-21	-19	-14	-11	-11	-11	-12	-10	-10
% Change	0.0%	0.0%	0.0%	-0.8%	-1.0%	-0.9%	-0.7%	-0.6%	-0.6%	-0.6%	-0.6%	-0.5%	-0.6%
Returns Above Variable Costs ($/acre)													
Baseline	399.33	293.87	296.66	305.00	293.87	277.90	257.41	240.03	227.09	214.78	195.90	182.51	172.23
Scenario	399.33	293.87	296.66	299.81	287.49	272.43	253.82	237.57	224.77	212.22	193.08	180.27	169.90
Change	0.00	0.00	0.00	-5.20	-6.39	-5.46	-3.59	-2.46	-2.32	-2.55	-2.81	-2.24	-2.33
% Change	0.00%	0.00%	0.00%	-1.70%	-2.17%	-1.97%	-1.39%	-1.03%	-1.02%	-1.19%	-1.44%	-1.23%	-1.35%
Consumer Impact (million $)	0	0	0	-12.69	-11.17	-3.78	0.49	0.10	-1.90	-3.03	-3.16	-2.84	-2.64
Producer Impact (million $)	0	0	0	2.95	1.53	-5.09	-9.64	-9.87	-8.37	-7.47	-7.53	-8.03	-8.52
Net Impact (million $)	0	0	0	-9.74	-9.64	-8.88	-9.15	-9.77	-10.27	-10.50	-10.68	-10.87	-11.15

U.S. RICE
2,4-D WITHOUT ALTERNATIVE

US RICE SUPPLY AND UTILIZATION

VARIABLE/YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
HARVESTED AREA (1,000 Acres)													
Baseline	2833.0	3316.0	3100.0	3214.3	3188.8	3182.3	3173.0	3146.3	3103.2	3068.3	3040.6	3018.8	2997.4
Scenario	2833.0	3316.0	3100.0	3214.3	3172.2	3155.8	3122.8	3080.0	3035.9	3007.2	2983.4	2961.0	2937.7
Change	0.0	0.0	0.0	0.0	-16.6	-26.5	-50.2	-66.3	-67.3	-61.1	-57.2	-57.7	-59.6
% Change	0.0%	0.0%	0.0%	0.0%	-0.5%	-0.8%	-1.6%	-2.1%	-2.2%	-2.0%	-1.9%	-1.9%	-2.0%
SUPPLY (Million Cwt)													
Baseline	202.4	231.6	222.6	232.1	233.3	232.5	232.3	233.2	234.5	235.3	235.6	235.9	236.0
Scenario	202.4	231.6	222.6	219.6	215.8	215.9	217.8	219.1	219.7	219.8	219.9	220.4	220.7
Change	0.0	0.0	0.0	-12.5	-17.6	-16.6	-14.6	-14.1	-14.8	-15.5	-15.6	-15.5	-15.4
% Change	0.0%	0.0%	0.0%	-5.4%	-7.5%	-7.1%	-6.3%	-6.1%	-6.3%	-6.6%	-6.6%	-6.6%	-6.5%
PRODUCTION (Million Cwt)													
Baseline	156.1	197.8	178.4	185.7	185.3	185.9	186.2	185.4	183.6	182.3	181.4	180.9	180.3
Scenario	156.1	197.8	178.4	173.0	172.9	172.9	171.8	170.1	168.4	167.5	166.9	166.3	165.7
Change	0.0	0.0	0.0	-12.7	-12.4	-13.0	-14.4	-15.3	-15.2	-14.8	-14.5	-14.5	-14.6
% Change	0.0%	0.0%	0.0%	-6.8%	-6.7%	-7.0%	-7.7%	-8.2%	-8.3%	-8.1%	-8.0%	-8.0%	-8.1%
IMPORTS (Million Cwt)													
Baseline	6.9	8.0	8.9	10.7	11.7	12.4	12.7	12.9	13.3	13.9	14.5	15.1	15.6
Scenario	6.9	8.0	8.9	10.9	11.3	11.7	12.2	12.8	13.4	14.0	14.5	15.1	15.7
Change	0.0	0.0	0.0	0.2	-0.4	-0.7	-0.5	-0.1	0.1	0.1	0.1	0.0	0.1
% Change	0.0%	0.0%	0.0%	1.9%	-3.3%	-5.5%	-3.8%	-0.9%	0.7%	0.8%	0.4%	0.3%	0.4%
DOMESTIC USE (Million Cwt)													
Baseline	101.5	104.2	104.6	106.7	108.7	110.5	112.1	113.6	115.0	116.4	117.9	119.3	120.7
Scenario	101.5	104.2	104.6	106.6	108.4	110.1	111.7	113.3	114.8	116.2	117.7	119.1	120.5
Change	-0.0	0.0	0.0	-0.1	-0.3	-0.4	-0.4	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2
% Change	-0.0%	0.0%	0.0%	-0.1%	-0.3%	-0.3%	-0.3%	-0.3%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
Food Use (Million Cwt)													
Baseline	71.2	74.0	76.1	78.0	79.7	81.3	82.9	84.3	85.7	87.1	88.5	89.9	91.2
Scenario	71.2	74.0	76.1	77.9	79.5	81.0	82.6	84.1	85.6	87.0	88.3	89.7	91.1
Change	0.0	0.0	0.0	-0.1	-0.2	-0.3	-0.3	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1
% Change	0.0%	0.0%	0.0%	-0.1%	-0.3%	-0.4%	-0.3%	-0.2%	-0.2%	-0.2%	-0.1%	-0.1%	-0.1%
Other Uses (Million Cwt)													
Baseline	19.3	19.2	19.5	19.8	20.0	20.1	20.2	20.3	20.3	20.3	20.4	20.4	20.5
Scenario	19.3	19.2	19.5	19.7	19.9	20.1	20.1	20.2	20.2	20.3	20.3	20.4	20.4
Change	0.0	0.0	0.0	-0.0	-0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
% Change	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.4%	-0.5%	-0.5%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%
EXPORTS (Million Cwt)													
Baseline	75.2	92.0	82.3	89.0	90.5	88.6	85.3	82.1	80.3	79.2	77.8	76.5	74.9
Scenario	75.2	92.0	82.3	81.4	76.1	72.1	69.9	68.0	66.5	65.1	63.4	62.0	60.5
Change	0.0	0.0	0.0	-7.6	-14.4	-16.5	-15.5	-14.1	-13.8	-14.1	-14.4	-14.5	-14.4
% Change	0.0%	0.0%	0.0%	-8.5%	-15.9%	-18.6%	-18.1%	-17.2%	-17.2%	-17.8%	-18.5%	-18.9%	-19.2%
TOTAL USE (Million Cwt)													
Baseline	176.7	196.2	186.9	195.7	199.2	199.1	197.4	195.7	195.4	195.6	195.7	195.8	195.6
Scenario	176.7	196.2	186.9	188.1	184.5	182.2	181.6	181.2	181.3	181.3	181.1	181.1	181.1
Change	0.0	0.0	0.0	-7.7	-14.7	-16.9	-15.8	-14.4	-14.0	-14.3	-14.6	-14.7	-14.6
% Change	0.0%	0.0%	0.0%	-3.9%	-7.4%	-8.5%	-8.0%	-7.4%	-7.2%	-7.3%	-7.5%	-7.5%	-7.4%
ENDING STOCKS (Million Cwt)													
Baseline	25.8	35.4	35.7	36.3	34.1	33.4	34.9	37.6	39.1	39.7	39.9	40.1	40.4
Scenario	25.8	35.4	35.7	31.6	31.2	33.7	36.2	37.9	38.3	38.5	38.9	39.3	39.6
Change	0.0	0.0	0.0	-4.8	-2.9	0.3	1.3	0.3	-0.8	-1.2	-1.0	-0.8	-0.8
% Change	0.0%	0.0%	0.0%	-13.2%	-8.5%	0.9%	3.6%	0.8%	-2.1%	-3.0%	-2.5%	-2.0%	-2.0%
FARM PRICE (Dollars per Cwt)													
Baseline	8.09	6.68	6.48	6.66	7.11	7.44	7.56	7.53	7.60	7.76	8.00	8.21	8.43
Scenario	8.09	6.68	6.48	7.30	7.69	7.63	7.51	7.51	7.69	7.92	8.16	8.34	8.56
Change	0.00	0.00	0.00	0.65	0.58	0.19	-0.04	-0.02	0.09	0.16	0.16	0.14	0.13
% Change	0.0%	0.0%	0.0%	9.7%	8.1%	2.6%	-0.5%	-0.3%	1.2%	2.1%	2.0%	1.7%	1.5%
YIELD (pounds/acre)													
Baseline	5510	5964	5753	5777	5812	5842	5869	5893	5917	5942	5966	5991	6016
Scenario	5510	5964	5753	5383	5452	5480	5502	5523	5546	5571	5594	5618	5642
Change	0.00	0.00	0.00	-393.75	-360.26	-362.89	-366.98	-369.63	-370.70	-371.39	-372.35	-373.63	-374.87
% Change	0.0%	0.0%	0.0%	-6.8%	-6.2%	-6.2%	-6.3%	-6.3%	-6.3%	-6.3%	-6.2%	-6.2%	-6.2%

AGRM 1995 WORLD AND U.S. RICE PRICE PROJECTIONS
2,4-D WITHOUT ALTERNATIVE

PRICE/ YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 .	2005
THAI PRICE (FOB), US$/mt													
Baseline	271.00	280.00	254.00	251.39	262.90	273.10	283.55	290.40	295.30	299.60	307.80	312.80	321.90
Scenario	271.00	280.00	254.00	281.65	306 40	304.50	295 45	291.70	296.30	304.00	314.10	318.50	326.00
Change	0.00	0.00	0.00	30.26	43.50	31.40	11.90	1.30	1.00	4.40	6.30	5.70	4.10
% Change	0.00%	0.00%	0.00%	12.04%	16.55%	11.50%	4.20%	0.45%	0.34%	1.47%	2.05%	1.82%	1.27%
U.S. EXPORT PRICE (FOB), US$/mt													
Baseline	457.45	319.67	333.42	335.80	349.77	362.77	376.24	387.09	396.59	405.78	418.21	427.96	441.21
Scenario	457.45	319.67	333.42	360.18	384.81	388.06	385.83	388.13	397.40	409.32	423.29	432.55	444.51
Change	0.00	0.00	0.00	24.37	35.04	25.29	9.59	1.05	0.81	3.54	5.07	4.59	3.30
% Change	0.00%	0.00%	0.00%	7.26%	10.02%	6.97%	2.55%	0.27%	0.20%	0.87%	1.21%	1.07%	0.75%
U.S. EXPORT PRICE (FOB), $/cwt milled													
Baseline	20.75	14.50	15.12	15.23	15.87	16.46	17.07	17.56	17.99	18.41	18.97	19.41	20.01
Scenario	20.75	14.50	15.12	16.34	17.45	17.60	17.50	17.61	18.03	18.57	19.20	19.62	20.16
Change	0.00	0.00	0.00	1.11	1.59	1.15	0.43	0.05	0.04	0.16	0.23	0.21	0.15
% Change	0.00%	0.00%	0.00%	7.26%	10.02%	6.97%	2.55%	0.27%	0.20%	0.87%	1.21%	1.07%	0.75%
U.S. FARM PRICE, $/cwt rough													
Baseline	8.09	6.68	6.48	6.66	7.11	7.44	7.56	7.53	7.60	7.76	8.00	8.21	8.43
Scenario	8.09	6.68	6.48	7.30	7.69	7.63	7.51	7.51	7.69	7.92	8.16	8.34	8.56
Change	0.00	0.00	0.00	0.65	0.58	0.19	-0.04	-0.02	0.09	0.16	0.16	0.14	0.13
% Change	0.00%	0.00%	0.00%	9.70%	8.14%	2.60%	-0.55%	-0.28%	1.25%	2.09%	2.02%	1.68%	1.51%
U.S. BREWERS PRICE, $/cwt milled													
Baseline	7.41	8.08	8.18	8.31	8.54	8.86	9.19	9.50	9.78	10.07	10.38	10.72	11.06
Scenario	7.41	8.08	8.18	8.31	8.66	9.01	9.28	9.52	9.78	10.09	10.42	10.76	11.11
Change	0.00	0.00	0.00	0.00	0.12	0.15	0.09	0.03	0.01	0.02	0.04	0.04	0.04
% Change	0.00%	0.00%	0.00%	0.00%	1.43%	1.75%	1.02%	0.28%	0.06%	0.20%	0.37%	0.42%	0.38%
U.S. RETAIL PRICE, cents/lb milled													
Baseline	45.59	41.55	39.09	39.35	40.82	42.56	44.20	45.44	46.44	47.54	48.97	50.29	51.84
Scenario	45.59	41.55	39.09.	40.93	43.85	44.88	45.05	45.46	46.47	47.88	49.49	50.78	52.21
Change	0.00	0.00	0.00	1.57	3.03	2.32	0.85	0.02	0.03	0.34	0.52	0.49	0.38
% Change	0.00%	0.00%	0.00%	4.00%	7.43%	5.46%	1.92%	0.04%	0.06%	0.72%	1.07%	0.97%	0.73%

AGRM 1995 U.S. FARM INCOME IMPACT PROJECTIONS
2,4-D WITHOUT ALTERNATIVE

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Production Market Value (million $)													
Baseline	1263	1321	1155	1236	1318	1383	1407	1396	1395	1415	1451	1484	1520
Scenario	1263	1321	1155	1263	1330	1320	1291	1277	1295	1327	1361	1388	1418
Change	0	0	0	27	12	-63	-116	-119	-100	-88	-89	-96	-102
% Change	0.0%	0.0%	0.0%	2.2%	0.9%	-4.6%	-8.2%	-8.5%	-7.2%	-6.2%	-6.1%	-6.5%	-6.7%
Government Program Cost (million $)													
Baseline	785	757	817	856	740	648	588	564	534	491	421	377	342
Scenario	785	757	817	632	478	492	542	556	511	446	384	355	322
Change	0	0	0	-225	-262	-156	-45	-8	-23	-45	-37	-22	-20
% Change	0.0%	0.0%	0.0%	-26.2%	-35.4%	-24.1%	-7.7%	-1.4%	-4.3%	-9.2%	-8.9%	-5.8%	-5.9%
Total Income (million $)													
Baseline	2048	2078	1972	2092	2058	2031	1995	1960	1929	1906	1872	1861	1862
Scenario	2048	2078	1972	1895	1809	1812	1833	1834	1806	1773	1745	1743	1740
Change	0	0	0	-197	-250	-219	-161	-126	-123	-133	-126	-118	-122
% Change	0.0%	0.0%	0.0%	-9.4%	-12.1%	-10.8%	-8.1%	-6.4%	-6.4%	-7.0%	-6.8%	-6.4%	-6.6%
Returns Above Variable Costs ($/acre)													
Baseline	399.33	293.87	296.66	305.00	293.87	277.90	257.41	240.03	227.09	214.78	195.90	182.51	172.23
Scenario	399.33	293.87	296.66	243.69	218.85	214.24	216.59	213.40	201.41	184.28	166.40	155.76	144.50
Change	0.00	0.00	0.00	-61.31	-75.03	-63.66	-40.82	-26.63	-25.68	-30.49	-29.50	-26.75	-27.73
% Change	0.00%	0.00%	0.00%	-20.10%	-25.53%	-22.91%	-15.86%	-11.10%	-11.31%	-14.20%	-15.06%	-14.66%	-16.10%
Consumer Impact (million $)	0	0	0	-145.82	-130.09	-43.32	9.27	4.71	-21.52	-37.00	-36.76	-31.38	-29.06
Producer Impact (million $)	0	0	0	27.48	12.04	-63.28	-115.91	-118.69	-99.78	-87.62	-89.20	-96.31	-102.01
Net Impact (million $)	0	0	0	-118.34	-118.05	-106.60	-106.64	-113.98	-121.30	-124.61	-125.96	-127.69	-131.07

U.S. RICE
CARBOFURAN WITH ALTERNATIVE

US RICE SUPPLY AND UTILIZATION

VARIABLE/YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
HARVESTED AREA (1,000 Acres)													
Baseline	2833.0	3316.0	3100.0	3214.3	3188.8	3182.3	3173.0	3146.3	3103.2	3068.3	3040.6	3018.8	2997.4
Scenario	2833.0	3316.0	3100.0	3214.3	3187.2	3179.2	3166.4	3137.7	3094.4	3060.2	3033.0	3011.1	2989.5
Change	0.0	0.0	0.0	0.0	-1.6	-3.2	-6.6	-8.6	-8.8	-8.1	-7.6	-7.7	-7.9
% Change	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.2%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%
SUPPLY (Million Cwt)													
Baseline	202.4	231.6	222.6	232.1	233.3	232.5	232.3	233.2	234.5	235.3	235.6	235.9	236.0
Scenario	202.4	231.6	222.6	230.4	231.0	230.2	230.3	231.3	232.5	233.2	233.4	233.7	233.9
Change	0.0	0.0	0.0	-1.7	-2.4	-2.2	-2.0	-2.0	-2.0	-2.1	-2.1	-2.1	-2.1
% Change	0.0%	0.0%	0.0%	-0.7%	-1.0%	-1.0%	-0.9%	-0.8%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%
PRODUCTION (Million Cwt)													
Baseline	156.1	197.8	178.4	185.7	185.3	185.9	186.2	185.4	183.6	182.3	181.4	180.9	180.3
Scenario	156.1	197.8	178.4	183.9	183.7	184.2	184.2	183.3	181.5	180.3	179.4	178.9	178.3
Change	0.0	0.0	0.0	-1.7	-1.7	-1.8	-2.0	-2.1	-2.1	-2.0	-2.0	-2.0	-2.0
% Change	0.0%	0.0%	0.0%	-0.9%	-0.9%	-0.9%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%
IMPORTS (Million Cwt)													
Baseline	6.9	8.0	8.9	10.7	11.7	12.4	12.7	12.9	13.3	13.9	14.5	15.1	15.6
Scenario	6.9	8.0	8.9	10.7	11.6	12.3	12.7	12.9	13.3	13.9	14.5	15.1	15.6
Change	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.0	0.0	0.0	0.0	0.0	0.0
% Change	0.0%	0.0%	0.0%	0.3%	-0.5%	-0.8%	-0.5%	-0.1%	0.1%	0.1%	0.1%	0.0%	0.1%
DOMESTIC USE (Million Cwt)													
Baseline	101.5	104.2	104.6	106.7	108.7	110.5	112.1	113.6	115.0	116.4	117.9	119.3	120.7
Scenario	101.5	104.2	104.6	106.7	108.7	110.4	112.0	113.5	115.0	116.4	117.8	119.3	120.7
Change	-0.0	0.0	0.0	-0.0	-0.0	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
% Change	-0.0%	0.0%	0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%
Food Use (Million Cwt)													
Baseline	71.2	74.0	76.1	78.0	79.7	81.3	82.9	84.3	85.7	87.1	88.5	89.9	91.2
Scenario	71.2	74.0	76.1	78.0	79.7	81.3	82.8	84.3	85.7	87.1	88.5	89.8	91.2
Change	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
% Change	0.0%	0.0%	0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%
Other Uses (Million Cwt)													
Baseline	19.3	19.2	19.5	19.8	20.0	20.1	20.2	20.3	20.3	20.3	20.4	20.4	20.5
Scenario	19.3	19.2	19.5	19.8	20.0	20.1	20.2	20.3	20.3	20.3	20.4	20.4	20.5
Change	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
% Change	0.0%	0.0%	0.0%	-0.0%	-0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
EXPORTS (Million Cwt)													
Baseline	75.2	92.0	82.3	89.0	90.5	88.6	85.3	82.1	80.3	79.2	77.8	76.5	74.9
Scenario	75.2	92.0	82.3	88.0	88.5	86.4	83.2	80.1	78.4	77.2	75.8	74.5	72.9
Change	0.0	0.0	0.0	-1.0	-1.9	-2.2	-2.1	-2.0	-1.9	-1.9	-2.0	-2.0	-2.0
% Change	0.0%	0.0%	0.0%	-1.2%	-2.2%	-2.5%	-2.5%	-2.4%	-2.4%	-2.5%	-2.5%	-2.6%	-2.6%
TOTAL USE (Million Cwt)													
Baseline	176.7	196.2	186.9	195.7	199.2	199.1	197.4	195.7	195.4	195.6	195.7	195.8	195.6
Scenario	176.7	196.2	186.9	194.7	197.2	196.8	195.2	193.7	193.4	193.6	193.7	193.8	193.6
Change	0.0	0.0	0.0	-1.0	-2.0	-2.3	-2.2	-2.0	-1.9	-2.0	-2.0	-2.0	-2.0
% Change	0.0%	0.0%	0.0%	-0.5%	-1.0%	-1.1%	-1.1%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%
ENDING STOCKS (Million Cwt)													
Baseline	25.8	35.4	35.7	36.3	34.1	33.4	34.9	37.6	39.1	39.7	39.9	40.1	40.4
Scenario	25.8	35.4	35.7	35.7	33.8	33.4	35.1	37.6	39.0	39.6	39.8	40.0	40.3
Change	0.0	0.0	0.0	-0.7	-0.4	0.0	0.2	0.0	-0.1	-0.2	-0.1	-0.1	-0.1
% Change	0.0%	0.0%	0.0%	-1.8%	-1.1%	0.1%	0.4%	0.1%	-0.3%	-0.4%	-0.3%	-0.3%	-0.3%
FARM PRICE (Dollars per Cwt)													
Baseline	8.09	6.68	6.48	6.66	7.11	7.44	7.56	7.53	7.60	7.76	8.00	8.21	8.43
Scenario	8.09	6.68	6.48	6.74	7.19	7.46	7.55	7.53	7.61	7.78	8.02	8.23	8.45
Change	0.00	0.00	0.00	0.09	0.08	0.03	-0.00	-0.00	0.01	0.02	0.02	0.02	0.02
% Change	0.0%	0.0%	0.0%	1.3%	1.1%	0.4%	-0.0%	-0.0%	0.2%	0.3%	0.3%	0.2%	0.2%
YIELD (pounds/acre)													
Baseline	5510	5964	5753	5777	5812	5842	5869	5893	5917	5942	5966	5991	6016
Scenario	5510	5964	5753	5723	5763	5793	5818	5842	5866	5891	5915	5940	5965
Change	0.00	0.00	0.00	-53.94	-49.13	-49.52	-50.14	-50.56	-50.73	-50.82	-50.95	-51.13	-51.31
% Change	0.0%	0.0%	0.0%	-0.9%	-0.8%	-0.8%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%	-0.9%

AGRM 1995 WORLD AND U.S. RICE PRICE PROJECTIONS
CARBOFURAN WITH ALTERNATIVE

PRICE/ YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
THAI PRICE (FOB), US$/mt													
Baseline	271.00	280 00	254.00	251.39	262.90	273.10	283.55	290.40	295.30	299.60	307.80	312.80	321.90
Scenario	271.00	280.00	254.00	255.50	268.75	277.25	285.30	290.75	295.55	300.20	308.60	313.70	322.50
Change	0.00	0.00	0.00	4.11	5.85	4.15	1.75	0.35	0.25	0.60	0.80	0.90	0.60
% Change	0.00%	0.00%	0.00%	1.63%	2.23%	1.52%	0.62%	0.12%	0.08%	0.20%	0.26%	0.29%	0.19%
U.S. EXPORT PRICE (FOB), US$/mt													
Baseline	457.45	319.67	333.42	335.80	349.77	362.77	376.24	387.09	396.59	405.78	418.21	427.96	441.21
Scenario	457.45	319.67	333.42	339.11	354.48	366.11	377.65	387.37	396.80	406.26	418.86	428.69	441.69
Change	0 00	0.00	0.00	3.31	4.71	3.34	1.41	0.28	0.20	0.48	0.64	0.72	0.48
% Change	0.00%	0.00%	0.00%	0.99%	1.35%	0.92%	0.37%	0.07%	0.05%	0.12%	0.15%	0.17%	0.11%
U.S. EXPORT PRICE (FOB), $/cwt milled													
Baseline	20.75	14.50	15.12	15.23	15.87	16.46	17.07	17.56	17.99	18.41	18.97	19.41	20.01
Scenario	20.75	14.50	15.12	15.38	16.08	16.61	17.13	17.57	18.00	18.43	19.00	19.45	20.03
Change	0.00	0.00	0.00	0.15	0.21	0.15	0.06	0.01	0.01	0.02	0.03	0.03	0.02
% Change	0.00%	0.00%	0.00%	0.99%	1.35%	0.92%	0.37%	0.07%	0.05%	0.12%	0.15%	0.17%	0.11%
U.S. FARM PRICE, $/cwt rough													
Baseline	8.09	6.68	6.48	6.66	7.11	7.44	7.56	7.53	7.60	7.76	8.00	8.21	8.43
Scenario	8.09	6.68	6.48	6.74	7.19	7.46	7.55	7.53	7.61	7.78	8.02	8.23	8.45
Change	0.00	0.00	0.00	0.09	0.08	0.03	-0.00	-0.00	0.01	0.02	0.02	0.02	0.02
% Change	0.00%	0.00%	0.00%	1.33%	1.09%	0.35%	-0.04%	-0.02%	0.17%	0.28%	0.27%	0.24%	0.21%
U.S. BREWERS PRICE, $/cwt milled													
Baseline	7.41	8.08	8.18	8.31	8.54	8.86	9.19	9.50	9.78	10.07	10.38	10.72	11.06
Scenario	7.41	8.08	8.18	8.31	8.56	8.88	9.20	9.50	9.78	10.07	10.39	10.72	11.07
Change	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.00	0.00	0.00	0.01	0.01	0.01
% Change	0.00%	0.00%	0.00%	0.00%	0.20%	0.24%	0.14%	0.04%	0.01%	0.03%	0.05%	0.06%	0.05%
U.S. RETAIL PRICE, cents/lb milled													
Baseline	45.59	41.55	39.09	39.35	40.82	42.56	44.20	45.44	46.44	47.54	48.97	50.29	51.84
Scenario	45.59	41.55	39.09	39.56	41.23	42.87	44.32	45.46	46.45	47.58	49.03	50.36	51.89
Change	0.00	0.00	0.00	0.21	0.41	0.31	0.12	0.01	0.01	0.05	0.07	0.07	0.05
% Change	0.00%	0.00%	0.00%	0.54%	1.00%	0.73%	0.28%	0.03%	0.03%	0.10%	0.14%	0.14%	0.11%

AGRM 1995 U.S. FARM INCOME IMPACT PROJECTIONS
CARBOFURAN WITH ALTERNATIVE

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Production Market Value (million $)													
Baseline	1263	1321	1155	1236	1318	1383	1407	1396	1395	1415	1451	1484	1520
Scenario	1263	1321	1155	1240	1321	1375	1391	1380	1381	1403	1439	1471	1507
Change	0	0	0	5	2	-8	-15	-16	-14	-12	-12	-13	-14
% Change	0.0%	0.0%	0.0%	0.4%	0.2%	-0.6%	-1.1%	-1.1%	-1.0%	-0.8%	-0.8%	-0.9%	-0.9%
Government Program Cost (million $)													
Baseline	785	757	817	856	740	648	588	564	534	491	421	377	342
Scenario	785	757	817	825	704	627	580	562	530	485	414	374	339
Change	0	0	0	-32	-37	-22	-7	-2	-4	-6	-7	-3	-3
% Change	0.0%	0.0%	0.0%	-3.7%	-4.9%	-3.3%	-1.3%	-0.4%	-0.7%	-1.3%	-1.6%	-0.8%	-0.8%
Total Income (million $)													
Baseline	2048	2078	1972	2092	2058	2031	1995	1960	1929	1906	1872	1861	1862
Scenario	2048	2078	1972	2065	2024	2001	1972	1942	1911	1887	1853	1845	1846
Change	0	0	0	-27	-34	-30	-23	-18	-17	-18	-19	-16	-17
% Change	0.0%	0.0%	0.0%	-1.3%	-1.7%	-1.5%	-1.1%	-0.9%	-0.9%	-1.0%	-1.0%	-0.9%	-0.9%
Returns Above Variable Costs ($/acre)													
Baseline	399.33	293.87	296.66	305.00	293.87	277.90	257.41	240.03	227.09	214.78	195.90	182.51	172.23
Scenario	399.33	293.87	296.66	296.65	283.56	269.18	251.59	236.15	223.47	210.65	191.39	178.93	168.50
Change	0.00	0.00	0.00	-8.35	-10.31	-8.72	-5.82	-3.88	-3.63	-4.12	-4.50	-3.58	-3.73
% Change	0.00%	0.00%	0.00%	-2.74%	-3.51%	-3.14%	-2.26%	-1.62%	-1.60%	-1.92%	-2.30%	-1.96%	-2.16%
Consumer Impact (million $)	0	0	0	-20.39	-18.04	-6.03	0.72	0.27	-3.04	-5.01	-5.06	-4.60	-4.12
Producer Impact (million $)	0	0	0	4.68	2.46	-8.28	-15.49	-15.99	-13.53	-11.95	-12.13	-12.92	-13.81
Net Impact (million $)	0	0	0	-15.71	-15.58	-14.31	-14.77	-15.72	-16.56	-16.96	-17.19	-17.52	-17.93

U.S. RICE
CARBOFURAN WITHOUT ALTERNATIVE

US RICE SUPPLY AND UTILIZATION

VARIABLE/YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
HARVESTED AREA (1,000 Acres)													
Baseline	2833.0	3316.0	3100.0	3214.3	3188.8	3182.3	3173.0	3146.3	3103.2	3068.3	3040.6	3018.8	2997.4
Scenario	2833.0	3316.0	3100.0	3214.3	3185.5	3176.0	3160.2	3129.5	3086.1	3052.6	3025.8	3003.8	2982.0
Change	0.0	0.0	0.0	0.0	-3.4	-6.3	-12.8	-16.8	-17.1	-15.7	-14.8	-14.9	-15.4
% Change	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.4%	-0.5%	-0.6%	-0.5%	-0.5%	-0.5%	-0.5%
SUPPLY (Million Cwt)													
Baseline	202.4	231.6	222.6	232.1	233.3	232.5	232.3	233.2	234.5	235.3	235.6	235.9	236.0
Scenario	202.4	231.6	222.6	228.8	228.8	228.1	228.5	229.5	230.6	231.2	231.5	231.8	232.0
Change	0.0	0.0	0.0	-3.3	-4.6	-4.3	-3.9	-3.8	-3.9	-4.1	-4.1	-4.1	-4.1
% Change	0.0%	0.0%	0.0%	-1.4%	-2.0%	-1.9%	-1.7%	-1.6%	-1.7%	-1.7%	-1.8%	-1.7%	-1.7%
PRODUCTION (Million Cwt)													
Baseline	156.1	197.8	178.4	185.7	185.3	185.9	186.2	185.4	183.6	182.3	181.4	180.9	180.3
Scenario	156.1	197.8	178.4	182.3	182.1	182.5	182.4	181.4	179.6	178.4	177.6	177.0	176.5
Change	0.0	0.0	0.0	-3.3	-3.2	-3.4	-3.8	-4.0	-4.0	-3.9	-3.9	-3.9	-3.9
% Change	0.0%	0.0%	0.0%	-1.8%	-1.7%	-1.8%	-2.0%	-2.2%	-2.2%	-2.2%	-2.1%	-2.1%	-2.1%
IMPORTS (Million Cwt)													
Baseline	6.9	8.0	8.9	10.7	11.7	12.4	12.7	12.9	13.3	13.9	14.5	15.1	15.6
Scenario	6.9	8.0	8.9	10.7	11.6	12.2	12.6	12.9	13.3	13.9	14.5	15.1	15.7
Change	0.0	0.0	0.0	0.1	-0.1	-0.2	-0.1	-0.0	0.0	0.0	0.0	0.0	0.0
% Change	0.0%	0.0%	0.0%	0.5%	-0.9%	-1.5%	-1.0%	-0.2%	0.2%	0.2%	0.1%	0.1%	0.1%
DOMESTIC USE (Million Cwt)													
Baseline	101.5	104.2	104.6	106.7	108.7	110.5	112.1	113.6	115.0	116.4	117.9	119.3	120.7
Scenario	101.5	104.2	104.6	106.7	108.6	110.4	112.0	113.5	115.0	116.4	117.8	119.2	120.7
Change	-0.0	0.0	0.0	-0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.0
% Change	-0.0%	0.0%	0.0%	-0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.0%	-0.0%	-0.0%	-0.0%
Food Use (Million Cwt)													
Baseline	71.2	74.0	76.1	78.0	79.7	81.3	82.9	84.3	85.7	87.1	88.5	89.9	91.2
Scenario	71.2	74.0	76.1	78.0	79.7	81.3	82.8	84.2	85.7	87.1	88.4	89.8	91.2
Change	0.0	0.0	0.0	-0.0	-0.1	-0.1	-0.1	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0
% Change	0.0%	0.0%	0.0%	-0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%
Other Uses (Million Cwt)													
Baseline	19.3	19.2	19.5	19.8	20.0	20.1	20.2	20.3	20.3	20.3	20.4	20.4	20.5
Scenario	19.3	19.2	19.5	19.8	20.0	20.1	20.2	20.3	20.3	20.3	20.4	20.4	20.5
Change	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
% Change	0.0%	0.0%	0.0%	-0.0%	-0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
EXPORTS (Million Cwt)													
Baseline	75.2	92.0	82.3	89.0	90.5	88.6	85.3	82.1	80.3	79.2	77.8	76.5	74.9
Scenario	75.2	92.0	82.3	87.0	86.7	84.3	81.3	78.3	76.7	75.4	74.0	72.7	71.1
Change	0.0	0.0	0.0	-2.0	-3.8	-4.3	-4.1	-3.8	-3.7	-3.7	-3.8	-3.8	-3.8
% Change	0.0%	0.0%	0.0%	-2.2%	-4.2%	-4.9%	-4.8%	-4.6%	-4.6%	-4.7%	-4.9%	-5.0%	-5.1%
TOTAL USE (Million Cwt)													
Baseline	176.7	196.2	186.9	195.7	199.2	199.1	197.4	195.7	195.4	195.6	195.7	195.8	195.6
Scenario	176.7	196.2	186.9	193.7	195.4	194.7	193.2	191.8	191.6	191.8	191.8	191.9	191.8
Change	0.0	0.0	0.0	-2.0	-3.8	-4.4	-4.2	-3.8	-3.7	-3.8	-3.9	-3.9	-3.9
% Change	0.0%	0.0%	0.0%	-1.0%	-1.9%	-2.2%	-2.1%	-2.0%	-1.9%	-1.9%	-2.0%	-2.0%	-2.0%
ENDING STOCKS (Million Cwt)													
Baseline	25.8	35.4	35.7	36.3	34.1	33.4	34.9	37.6	39.1	39.7	39.9	40.1	40.4
Scenario	25.8	35.4	35.7	35.1	33.4	33.5	35.2	37.6	38.9	39.4	39.6	39.9	40.2
Change	0.0	0.0	0.0	-1.3	-0.7	0.1	0.3	0.1	-0.2	-0.3	-0.3	-0.2	-0.2
% Change	0.0%	0.0%	0.0%	-3.5%	-2.2%	0.2%	0.9%	0.2%	-0.5%	-0.8%	-0.7%	-0.5%	-0.5%
FARM PRICE (Dollars per Cwt)													
Baseline	8.09	6.68	6.48	6.66	7.11	7.44	7.56	7.53	7.60	7.76	8.00	8.21	8.43
Scenario	8.09	6.68	6.48	6.83	7.26	7.49	7.55	7.53	7.62	7.80	8.04	8.24	8.47
Change	0.00	0.00	0.00	0.17	0.15	0.05	-0.01	-0.00	0.03	0.04	0.04	0.04	0.03
% Change	0.0%	0.0%	0.0%	2.6%	2.1%	0.7%	-0.1%	-0.0%	0.3%	0.5%	0.5%	0.4%	0.4%
YIELD (pounds/acre)													
Baseline	5510	5964	5753	5777	5812	5842	5869	5893	5917	5942	5966	5991	6016
Scenario	5510	5964	5753	5673	5717	5747	5772	5795	5819	5844	5868	5893	5917
Change	0.00	0.00	0.00	-104.02	-94.77	-95.51	-96.70	-97.49	-97.80	-97.97	-98.22	-98.57	-98.91
% Change	0.0%	0.0%	0.0%	-1.8%	-1.6%	-1.6%	-1.6%	-1.7%	-1.7%	-1.6%	-1.6%	-1.6%	-1.6%

AGRM 1995 WORLD AND U.S. RICE PRICE PROJECTIONS
CARBOFURAN WITHOUT ALTERNATIVE

PRICE/ YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
THAI PRICE (FOB), US$/mt													
Baseline	271.00	280.00	254.00	251.39	262.90	273.10	283.55	290.40	295.30	299.60	307.80	312.80	321.90
Scenario	271.00	280.00	254.00	259.40	274.20	281.20	286.80	291.00	295.80	300.75	309.40	314.30	323.05
Change	0.00	0.00	0.00	8.01	11.30	8.10	3.25	0.60	0.50	1.15	1.60	1.50	1.15
% Change	0.00%	0.00%	0.00%	3.19%	4.30%	2.97%	1.15%	0.21%	0.17%	0.38%	0.52%	0.48%	0.36%
U.S. EXPORT PRICE (FOB), US$/mt													
Baseline	457.45	319.67	333.42	335.80	349.77	362.77	376.24	387.09	396.59	405.78	418.21	427.96	441.21
Scenario	457.45	319.67	333.42	342.26	358.87	369.29	378.86	387.57	397.00	406.70	419.50	429.17	442.13
Change	0.00	0.00	0.00	6.45	9.10	6.52	2.62	0.48	0.40	0.93	1.29	1.21	0.93
% Change	0.00%	0.00%	0.00%	1.92%	2.60%	1.80%	0.70%	0.12%	0.10%	0.23%	0.31%	0.28%	0.21%
U.S. EXPORT PRICE (FOB), $/cwt milled													
Baseline	20.75	14.50	15.12	15.23	15.87	16.46	17.07	17.56	17.99	18.41	18.97	19.41	20.01
Scenario	20.75	14.50	15.12	15.52	16.28	16.75	17.18	17.58	18.01	18.45	19.03	19.47	20.05
Change	0.00	0.00	0.00	0.29	0.41	0.30	0.12	0.02	0.02	0.04	0.06	0.05	0.04
% Change	0.00%	0.00%	0.00%	1.92%	2.60%	1.80%	0.70%	0.12%	0.10%	0.23%	0.31%	0.28%	0.21%
U.S. FARM PRICE, $/cwt rough													
Baseline	8.09	6.68	6.48	6.66	7.11	7.44	7.56	7.53	7.60	7.76	8.00	8.21	8.43
Scenario	8.09	6.68	6.48	6.83	7.26	7.49	7.55	7.53	7.62	7.80	8.04	8.24	8.47
Change	0.00	0.00	0.00	0.17	0.15	0.05	-0.01	-0.00	0.03	0.04	0.04	0.04	0.03
% Change	0.00%	0.00%	0.00%	2.56%	2.11%	0.68%	-0.10%	-0.03%	0.34%	0.53%	0.52%	0.45%	0.41%
U.S. BREWERS PRICE, $/cwt milled													
Baseline	7.41	8.08	8.18	8.31	8.54	8.86	9.19	9.50	9.78	10.07	10.38	10.72	11.06
Scenario	7.41	8.08	8.18	8.31	8.57	8.90	9.22	9.51	9.78	10.07	10.39	10.73	11.07
Change	0.00	0.00	0.00	0.00	0.03	0.04	0.02	0.01	0.00	0.01	0.01	0.01	0.01
% Change	0.00%	0.00%	0.00%	0.00%	0.38%	0.46%	0.27%	0.08%	0.02%	0.06%	0.10%	0.11%	0.10%
U.S. RETAIL PRICE, cents/lb milled													
Baseline	45.59	41.55	39.09	39.35	40.82	42.56	44.20	45.44	46.44	47.54	48.97	50.29	51.84
Scenario	45.59	41.55	39.09	39.77	41.61	43.16	44.43	45.46	46.47	47.63	49.10	50.42	51.94
Change	0.00	0.00	0.00	0.42	0.79	0.60	0.23	0.02	0.02	0.09	0.13	0.13	0.10
% Change	0.00%	0.00%	0.00%	1.06%	1.94%	1.41%	0.52%	0.05%	0.05%	0.19%	0.27%	0.25%	0.20%

AGRM 1995 U.S. FARM INCOME IMPACT PROJECTIONS
CARBOFURAN WITHOUT ALTERNATIVE

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Production Market Value (million $)													
Baseline	1263	1321	1155	1236	1318	1383	1407	1396	1395	1415	1451	1484	1520
Scenario	1263	1321	1155	1245	1323	1367	1377	1365	1369	1392	1427	1459	1494
Change	0	0	0	9	4	-16	-30	-31	-26	-23	-23	-25	-27
% Change	0.0%	0.0%	0.0%	0.7%	0.3%	-1.2%	-2.1%	-2.2%	-1.9%	-1.6%	-1.6%	-1.7%	-1.7%
Government Program Cost (million $)													
Baseline	785	757	817	856	740	648	588	564	534	491	421	377	342
Scenario	785	757	817	795	670	606	574	560	527	479	408	371	336
Change	0	0	0	-61	-70	-42	-13	-4	-7	-12	-13	-6	-5
% Change	0.0%	0.0%	0.0%	-7.1%	-9.5%	-6.5%	-2.3%	-0.6%	-1.3%	-2.4%	-3.1%	-1.6%	-1.6%
Total Income (million $)													
Baseline	2048	2078	1972	2092	2058	2031	1995	1960	1929	1906	1872	1861	1862
Scenario	2048	2078	1972	2040	1993	1973	1951	1926	1895	1871	1835	1830	1830
Change	0	[illegible]	0	-52	-66	-58	-44	-34	-33	-35	-37	-31	-32
% Change	0.0%	0.0%	0.0%	-2.5%	-3.2%	-2.9%	-2.2%	-1.8%	-1.7%	-1.8%	-2.0%	-1.7%	-1.7%
Returns Above Variable Costs ($/acre)													
Baseline	399.33	293.87	296.66	305.00	293.87	277.90	257.41	240.03	227.09	214.78	195.90	182.51	172.23
Scenario	399.33	293.87	296.66	288.80	274.02	261.02	246.36	232.66	220.08	206.82	187.14	175.58	165.04
Change	0.00	0.00	0.00	-16.21	-19.86	-16.87	-11.04	-7.37	-7.01	-7.95	-8.76	-6.93	-7.19
% Change	0.00%	0.00%	0.00%	-5.31%	-6.76%	-6.07%	-4.29%	-3.07%	-3.09%	-3.70%	-4.47%	-3.80%	-4.17%
Consumer Impact (million $)	0	0	0	-39.25	-34.64	-11.61	1.67	0.54	-5.96	-9.63	-9.74	-8.59	-8.07
Producer Impact (million $)	0	0	0	8.81	4.44	-16.09	-30.09	-30.86	-26.02	-23.08	-23.43	-25.14	-26.58
Net Impact (million $)	0	0	0	-30.44	-30.20	-27.70	-28.42	-30.33	-31.98	-32.71	-33.17	-33.73	-34.65

U.S. RICE

BENOMYL WITH ALTERNATIVE

US RICE SUPPLY AND UTILIZATION

VARIABLE/YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
HARVESTED AREA (1,000 Acres)													
Baseline	2833.0	3316.0	3100.0	3214.3	3188.8	3182.3	3173.0	3146.3	3103.2	3068.3	3040.6	3018.8	2997.4
Scenario	2833.0	3316.0	3100.0	3214.3	3187.6	3178.5	3165.0	3136.0	3092.9	3058.8	3031.6	3009.6	2987.9
Change	0.0	0.0	0.0	0.0	-1.3	-3.8	-8.0	-10.2	-10.3	-9.4	-9.0	-9.1	-9.5
% Change	0.0%	0.0%	0.0%	0.0%	-0.0%	-0.1%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%
SUPPLY (Million Cwt)													
Baseline	202.4	231.6	222.6	232.1	233.3	232.5	232.3	233.2	234.5	235.3	235.6	235.9	236.0
Scenario	202.4	231.6	222.6	229.9	230.4	229.8	229.9	230.9	232.0	232.7	233.0	233.3	233.4
Change	0.0	0.0	0.0	-2.2	-2.9	-2.7	-2.4	-2.4	-2.5	-2.6	-2.6	-2.6	-2.6
% Change	0.0%	0.0%	0.0%	-1.0%	-1.2%	-1.2%	-1.0%	-1.0%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%
PRODUCTION (Million Cwt)													
Baseline	156.1	197.8	178.4	185.7	185.3	185.9	186.2	185.4	183.6	182.3	181.4	180.9	180.3
Scenario	156.1	197.8	178.4	183.4	183.4	183.8	183.8	182.9	181.1	179.8	179.0	178.4	177.9
Change	0.0	0.0	0.0	-2.3	-2.0	-2.1	-2.4	-2.5	-2.5	-2.5	-2.4	-2.5	-2.5
% Change	0.0%	0.0%	0.0%	-1.2%	-1.1%	-1.1%	-1.3%	-1.4%	-1.4%	-1.4%	-1.3%	-1.4%	-1.4%
IMPORTS (Million Cwt)													
Baseline	6.9	8.0	8.9	10.7	11.7	12.4	12.7	12.9	13.3	13.9	14.5	15.1	15.6
Scenario	6.9	8.0	8.9	10.7	11.6	12.3	12.6	12.9	13.3	13.9	14.5	15.1	15.6
Change	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.0	0.0	0.0	0.0	0.0	0.0
% Change	0.0%	0.0%	0.0%	0.4%	-0.6%	-0.9%	-0.6%	-0.1%	0.1%	0.1%	0.1%	0.0%	0.1%
DOMESTIC USE (Million Cwt)													
Baseline	101.5	104.2	104.6	106.7	108.7	110.5	112.1	113.6	115.0	116.4	117.9	119.3	120.7
Scenario	101.5	104.2	104.6	106.7	108.7	110.4	112.0	113.5	115.0	116.4	117.8	119.3	120.7
Change	-0.0	0.0	0.0	-0.0	-0.0	-0.1	-0.1	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
% Change	-0.0%	0.0%	0.0%	-0.0%	-0.0%	-0.1%	-0.1%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%
Food Use (Million Cwt)													
Baseline	71.2	74.0	76.1	78.0	79.7	81.3	82.9	84.3	85.7	87.1	88.5	89.9	91.2
Scenario	71.2	74.0	76.1	78.0	79.7	81.3	82.8	84.3	85.7	87.1	88.4	89.8	91.2
Change	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
% Change	0.0%	0.0%	0.0%	-0.0%	-0.0%	-0.1%	-0.1%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%	-0.0%
Other Uses (Million Cwt)													
Baseline	19.3	19.2	19.5	19.8	20.0	20.1	20.2	20.3	20.3	20.3	20.4	20.4	20.5
Scenario	19.3	19.2	19.5	19.8	20.0	20.1	20.2	20.3	20.3	20.3	20.4	20.4	20.5
Change	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
% Change	0.0%	0.0%	0.0%	-0.0%	-0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
EXPORTS (Million Cwt)													
Baseline	75.2	92.0	82.3	89.0	90.5	88.6	85.3	82.1	80.3	79.2	77.8	76.5	74.9
Scenario	75.2	92.0	82.3	87.6	88.1	85.9	82.8	79.7	78.0	76.8	75.4	74.1	72.5
Change	0.0	0.0	0.0	-1.3	-2.4	-2.7	-2.5	-2.3	-2.3	-2.4	-2.4	-2.4	-2.4
% Change	0.0%	0.0%	0.0%	-1.5%	-2.7%	-3.0%	-3.0%	-2.8%	-2.9%	-3.0%	-3.1%	-3.2%	-3.3%
TOTAL USE (Million Cwt)													
Baseline	176.7	196.2	186.9	195.7	199.2	199.1	197.4	195.7	195.4	195.6	195.7	195.8	195.6
Scenario	176.7	196.2	186.9	194.4	196.7	196.3	194.8	193.3	193.0	193.2	193.2	193.3	193.2
Change	0.0	0.0	0.0	-1.4	-2.5	-2.8	-2.6	-2.4	-2.3	-2.4	-2.5	-2.5	-2.5
% Change	0.0%	0.0%	0.0%	-0.7%	-1.2%	-1.4%	-1.3%	-1.2%	-1.2%	-1.2%	-1.3%	-1.3%	-1.3%
ENDING STOCKS (Million Cwt)													
Baseline	25.8	35.4	35.7	36.3	34.1	33.4	34.9	37.6	39.1	39.7	39.9	40.1	40.4
Scenario	25.8	35.4	35.7	35.5	33.7	33.5	35.1	37.6	39.0	39.5	39.7	39.9	40.3
Change	0.0	0.0	0.0	-0.9	-0.4	0.1	0.2	0.0	-0.1	-0.2	-0.2	-0.1	-0.1
% Change	0.0%	0.0%	0.0%	-2.3%	-1.3%	0.2%	0.5%	0.1%	-0.4%	-0.5%	-0.4%	-0.3%	-0.3%
FARM PRICE (Dollars per Cwt)													
Baseline	8.09	6.68	6.48	6.66	7.11	7.44	7.56	7.53	7.60	7.76	8.00	8.21	8.43
Scenario	8.09	6.68	6.48	6.77	7.20	7.47	7.55	7.53	7.61	7.79	8.02	8.23	8.45
Change	0.00	0.00	0.00	0.11	0.09	0.03	-0.01	-0.00	0.02	0.03	0.03	0.02	0.02
% Change	0.0%	0.0%	0.0%	1.7%	1.3%	0.4%	-0.1%	-0.0%	0.2%	0.3%	0.3%	0.3%	0.3%
YIELD (pounds/acre)													
Baseline	5510	5964	5753	5777	5812	5842	5869	5893	5917	5942	5966	5991	6016
Scenario	5510	5964	5753	5707	5753	5782	5808	5831	5855	5880	5904	5928	5953
Change	0.00	0.00	0.00	-70.08	-59.51	-60.03	-60.92	-61.58	-61.97	-62.32	-62.73	-63.21	-63.70
% Change	0.0%	0.0%	0.0%	-1.2%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.1%	-1.1%	-1.1%

AGRM 1995 WORLD AND U.S. RICE PRICE PROJECTIONS

BENOMYL WITH ALTERNATIVE

PRICE/ YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
THAI PRICE (FOB), US$/mt													
Baseline	271.00	280.00	254.00	251.39	262.90	273.10	283.55	290.40	295.30	299.60	307.80	312.80	321.90
Scenario	271.00	280.00	254.00	256.75	270.00	277.90	285.40	290.75	295.70	300.40	308.90	313.85	322.75
Change	0.00	0.00	0.00	5.36	7.10	4.80	1.85	0.35	0.40	0.80	1.10	1.05	0.85
% Change	0.00%	0.00%	0.00%	2.13%	2.70%	1.76%	0.65%	0.12%	0.14%	0.27%	0.36%	0.34%	0.26%
U.S. EXPORT PRICE (FOB), US$/mt													
Baseline	457.45	319.67	333.42	335.80	349.77	362.77	376.24	387.09	396.59	405.78	418.21	427.96	441.21
Scenario	457.45	319.67	333.42	340.12	355.49	366.63	377.73	387.37	396.92	406.42	419.10	428.81	441.89
Change	0.00	0.00	0.00	4.32	5.72	3.87	1.49	0.28	0.32	0.64	0.89	0.85	0.68
% Change	0.00%	0.00%	0.00%	1.29%	1.64%	1.07%	0.40%	0.07%	0.08%	0.16%	0.21%	0.20%	0.16%
U.S. EXPORT PRICE (FOB), $/cwt milled													
Baseline	20.75	14.50	15.12	15.23	15.87	16.46	17.07	17.56	17.99	18.41	18.97	19.41	20.01
Scenario	20.75	14.50	15.12	15.43	16.12	16.63	17.13	17.57	18.00	18.44	19.01	19.45	20.04
Change	0.00	0.00	0.00	0.20	0.26	0.18	0.07	0.01	0.01	0.03	0.04	0.04	0.03
% Change	0.00%	0.00%	0.00%	1.29%	1.64%	1.07%	0.40%	0.07%	0.08%	0.16%	0.21%	0.20%	0.16%
U.S. FARM PRICE, $/cwt rough													
Baseline	8.09	6.68	6.48	6.66	7.11	7.44	7.56	7.53	7.60	7.76	8.00	8.21	8.43
Scenario	8.09	6.68	6.48	6.77	7.20	7.47	7.55	7.53	7.61	7.79	8.02	8.23	8.45
Change	0.00	0.00	0.00	0.11	0.09	0.03	-0.01	-0.00	0.02	0.03	0.03	0.02	0.02
% Change	0.00%	0.00%	0.00%	1.72%	1.28%	0.36%	-0.08%	-0.00%	0.23%	0.35%	0.34%	0.29%	0.27%
U.S. BREWERS PRICE, $/cwt milled													
Baseline	7.41	8.08	8.18	8.31	8.54	8.86	9.19	9.50	9.78	10.07	10.38	10.72	11.06
Scenario	7.41	8.08	8.18	8.31	8.56	8.88	9.21	9.50	9.78	10.07	10.39	10.73	11.07
Change	0.00	0.00	0.00	0.00	0.02	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.01
% Change	0.00%	0.00%	0.00%	0.00%	0.25%	0.28%	0.16%	0.04%	0.02%	0.04%	0.06%	0.07%	0.07%
U.S. RETAIL PRICE, cents/lb milled													
Baseline	45.59	41.55	39.09	39.35	40.82	42.56	44.20	45.44	46.44	47.54	48.97	50.29	51.84
Scenario	45.59	41.55	39.09	39.63	41.33	42.92	44.33	45.45	46.46	47.60	49.06	50.37	51.91
Change	0.00	0.00	0.00	0.28	0.51	0.36	0.13	0.01	0.02	0.06	0.09	0.09	0.07
% Change	0.00%	0.00%	0.00%	0.71%	1.24%	0.84%	0.29%	0.02%	0.04%	0.13%	0.18%	0.17%	0.14%

AGRM 1995 U.S. FARM INCOME IMPACT PROJECTIONS

BENOMYL WITH ALTERNATIVE

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Production Market Value (million $)													
Baseline	1263	1321	1155	1236	1318	1383	1407	1396	1395	1415	1451	1484	1520
Scenario	1263	1321	1155	1242	1321	1372	1388	1377	1379	1401	1436	1469	1504
Change	0	0	0	6	3	-11	-19	-19	-16	-14	-15	-16	-17
% Change	0.0%	0.0%	0.0%	0.5%	0.2%	-0.8%	-1.4%	-1.4%	-1.1%	-1.0%	-1.0%	-1.1%	-1.1%
Government Program Cost (million $)													
Baseline	785	757	817	856	740	648	588	564	534	491	421	377	342
Scenario	785	757	817	815	696	624	580	562	529	483	412	373	338
Change	0	0	0	-41	-44	-25	-8	-2	-5	-8	-9	-4	-4
% Change	0.0%	0.0%	0.0%	-4.8%	-5.9%	-3.8%	-1.3%	-0.4%	-1.0%	-1.6%	-2.1%	-1.0%	-1.1%
Total Income (million $)													
Baseline	2048	2078	1972	2092	2058	2031	1995	1960	1929	1906	1872	1861	1862
Scenario	2048	2078	1972	2057	2017	1996	1968	1939	1908	1883	1848	1841	1842
Change	0	0	0	-35	-41	-36	-27	-21	-21	-22	-23	-20	-20
% Change	0.0%	0.0%	0.0%	-1.7%	-2.0%	-1.7%	-1.3%	-1.1%	-1.1%	-1.2%	-1.3%	-1.1%	-1.1%
Returns Above Variable Costs ($/acre)													
Baseline	399.33	293.87	296.66	305.00	293.87	277.90	257.41	240.03	227.09	214.78	195.90	182.51	172.23
Scenario	399.33	293.87	296.66	294.13	281.09	267.34	250.40	235.10	222.19	209.23	189.77	177.60	167.10
Change	0.00	0.00	0.00	-10.87	-12.79	-10.56	-7.01	-4.93	-4.90	-5.55	-6.13	-4.91	-5.13
% Change	0.00%	0.00%	0.00%	-3.57%	-4.35%	-3.80%	-2.72%	-2.06%	-2.16%	-2.58%	-3.13%	-2.69%	-2.98%
Consumer Impact (million $)	0	0	0	-26.49	-21.07	-6.16	1.37	0.07	-4.13	-6.29	-6.35	-5.64	-5.38
Producer Impact (million $)	0	0	0	6.05	2.64	-10.95	-19.18	-19.14	-15.99	-14.31	-14.65	-15.81	-16.79
Net Impact (million $)	0	0	0	-20.44	-18.42	-17.11	-17.81	-19.07	-20.12	-20.60	-21.00	-21.46	-22.17

U.S. RICE
BENOMYL WITHOUT ALTERNATIVE

US RICE SUPPLY AND UTILIZATION

VARIABLE/YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
HARVESTED AREA (1,000 Acres)													
Baseline	2833.0	3316.0	3100.0	3214.3	3188.8	3182.3	3173.0	3146.3	3103.2	3068.3	3040.6	3018.8	2997.4
Scenario	2833.0	3316.0	3100.0	3214.3	3183.8	3169.6	3147.7	3113.6	3070.4	3038.4	3012.3	2989.9	2967.3
Change	0.0	0.0	0.0	0.0	-5.1	-12.7	-25.3	-32.6	-32.8	-29.9	-28.3	-28.9	-30.1
% Change	0.0%	0.0%	0.0%	0.0%	-0.2%	-0.4%	-0.8%	-1.0%	-1.1%	-1.0%	-0.9%	-1.0%	-1.0%
SUPPLY (Million Cwt)													
Baseline	202.4	231.6	222.6	232.1	233.3	232.5	232.3	233.2	234.5	235.3	235.6	235.9	236.0
Scenario	202.4	231.6	222.6	225.3	224.4	224.2	225.0	226.0	226.9	227.3	227.5	227.8	228.0
Change	0.0	0.0	0.0	-6.8	-8.9	-8.3	-7.3	-7.2	-7.6	-8.0	-8.1	-8.0	-8.0
% Change	0.0%	0.0%	0.0%	-2.9%	-3.8%	-3.6%	-3.2%	-3.1%	-3.3%	-3.4%	-3.4%	-3.4%	-3.4%
PRODUCTION (Million Cwt)													
Baseline	156.1	197.8	178.4	185.7	185.3	185.9	186.2	185.4	183.6	182.3	181.4	180.9	180.3
Scenario	156.1	197.8	178.4	178.7	179.2	179.3	178.8	177.6	175.8	174.7	173.9	173.3	172.7
Change	0.0	0.0	0.0	-6.9	-6.1	-6.6	-7.4	-7.8	-7.8	-7.6	-7.5	-7.5	-7.6
% Change	0.0%	0.0%	0.0%	-3.7%	-3.3%	-3.5%	-4.0%	-4.2%	-4.2%	-4.2%	-4.1%	-4.2%	-4.2%
IMPORTS (Million Cwt)													
Baseline	6.9	8.0	8.9	10.7	11.7	12.4	12.7	12.9	13.3	13.9	14.5	15.1	15.6
Scenario	6.9	8.0	8.9	10.8	11.4	12.0	12.5	12.9	13.4	13.9	14.5	15.1	15.7
Change	0.0	0.0	0.0	0.1	-0.2	-0.4	-0.2	-0.0	0.1	0.1	0.0	0.0	0.0
% Change	0.0%	0.0%	0.0%	1.1%	-1.9%	-2.9%	-1.8%	-0.4%	0.4%	0.4%	0.2%	0.1%	0.2%
DOMESTIC USE (Million Cwt)													
Baseline	101.5	104.2	104.6	106.7	108.7	110.5	112.1	113.6	115.0	116.4	117.9	119.3	120.7
Scenario	101.5	104.2	104.6	106.7	108.6	110.3	111.9	113.4	114.9	116.3	117.8	119.2	120.6
Change	-0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
% Change	-0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.2%	-0.2%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Food Use (Million Cwt)													
Baseline	71.2	74.0	76.1	78.0	79.7	81.3	82.9	84.3	85.7	87.1	88.5	89.9	91.2
Scenario	71.2	74.0	76.1	77.9	79.6	81.2	82.7	84.2	85.6	87.0	88.4	89.8	91.2
Change	0.0	0.0	0.0	-0.0	-0.1	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
% Change	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.2%	-0.2%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Other Uses (Million Cwt)													
Baseline	19.3	19.2	19.5	19.8	20.0	20.1	20.2	20.3	20.3	20.3	20.4	20.4	20.5
Scenario	19.3	19.2	19.5	19.8	20.0	20.1	20.2	20.2	20.3	20.3	20.4	20.4	20.4
Change	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
% Change	0.0%	0.0%	0.0%	-0.0%	-0.1%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
EXPORTS (Million Cwt)													
Baseline	75.2	92.0	82.3	89.0	90.5	88.6	85.3	82.1	80.3	79.2	77.8	76.5	74.9
Scenario	75.2	92.0	82.3	84.8	83.0	80.2	77.5	74.9	73.3	71.9	70.4	69.0	67.4
Change	0.0	0.0	0.0	-4.1	-7.5	-8.3	-7.8	-7.2	-7.1	-7.3	-7.4	-7.5	-7.5
% Change	0.0%	0.0%	0.0%	-4.7%	-8.3%	-9.4%	-9.1%	-8.7%	-8.8%	-9.2%	-9.6%	-9.8%	-10.0%
TOTAL USE (Million Cwt)													
Baseline	176.7	196.2	186.9	195.7	199.2	199.1	197.4	195.7	195.4	195.6	195.7	195.8	195.6
Scenario	176.7	196.2	186.9	191.5	191.6	190.5	189.4	188.3	188.2	188.2	188.1	188.2	188.0
Change	0.0	0.0	0.0	-4.2	-7.6	-8.5	-8.0	-7.3	-7.2	-7.4	-7.6	-7.6	-7.6
% Change	0.0%	0.0%	0.0%	-2.1%	-3.8%	-4.3%	-4.0%	-3.7%	-3.7%	-3.8%	-3.9%	-3.9%	-3.9%
ENDING STOCKS (Million Cwt)													
Baseline	25.8	35.4	35.7	36.3	34.1	33.4	34.9	37.6	39.1	39.7	39.9	40.1	40.4
Scenario	25.8	35.4	35.7	33.7	32.8	33.7	35.5	37.7	38.7	39.1	39.4	39.7	40.0
Change	0.0	0.0	0.0	-2.6	-1.3	0.3	0.6	0.1	-0.5	-0.6	-0.5	-0.4	-0.4
% Change	0.0%	0.0%	0.0%	-7.2%	-3.9%	0.8%	1.8%	0.2%	-1.2%	-1.5%	-1.3%	-1.0%	-1.0%
FARM PRICE (Dollars per Cwt)													
Baseline	8.09	6.68	6.48	6.66	7.11	7.44	7.56	7.53	7.60	7.76	8.00	8.21	8.43
Scenario	8.09	6.68	6.48	7.01	7.39	7.52	7.53	7.53	7.65	7.85	8.08	8.28	8.50
Change	0.00	0.00	0.00	0.35	0.28	0.08	-0.02	-0.00	0.05	0.09	0.08	0.07	0.07
% Change	0.0%	0.0%	0.0%	5.3%	4.0%	1.1%	-0.3%	-0.0%	0.7%	1.1%	1.0%	0.9%	0.8%
YIELD (pounds/acre)													
Baseline	5510	5964	5753	5777	5812	5842	5869	5893	5917	5942	5966	5991	6016
Scenario	5510	5964	5753	5561	5629	5658	5681	5704	5727	5751	5774	5797	5821
Change	0.00	0.00	0.00	-215.63	-182.82	-184.37	-187.08	-189.06	-190.24	-191.27	-192.52	-194.01	-195.50
% Change	0.0%	0.0%	0.0%	-3.7%	-3.1%	-3.2%	-3.2%	-3.2%	-3.2%	-3.2%	-3.2%	-3.2%	-3.2%

AGRM 1995 WORLD AND U.S. RICE PRICE PROJECTIONS
BENOMYL WITHOUT ALTERNATIVE

PRICE/ YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
THAI PRICE (FOB), US$/mt													
Baseline	271.00	280.00	254.00	251.39	262.90	273.10	283.55	290.40	295.30	299.60	307.80	312.80	321.90
Scenario	271.00	280.00	254.00	268.00	284.90	288.10	289.10	291.20	296.20	302.20	311.25	316.10	324.40
Change	0.00	0.00	0.00	16.61	22.00	15.00	5.55	0.80	0.90	2.60	3.45	3.30	2.50
% Change	0.00%	0.00%	0.00%	6.61%	8.37%	5.49%	1.96%	0.28%	0.30%	0.87%	1.12%	1.05%	0.78%
U.S. EXPORT PRICE (FOB), US$/mt													
Baseline	457.45	319.67	333.42	335.80	349.77	362.77	376.24	387.09	396.59	405.78	418.21	427.96	441.21
Scenario	457.45	319.67	333.42	349.18	367.49	374.85	380.71	387.73	397.32	407.87	420.99	430.62	443.22
Change	0.00	0.00	0.00	13.38	17.72	12.08	4.47	0.64	0.72	2.09	2.78	2.66	2.01
% Change	0.00%	0.00%	0.00%	3.98%	5.07%	3.33%	1.19%	0.17%	0.18%	0.52%	0.66%	0.62%	0.46%
U.S. EXPORT PRICE (FOB), $/cwt milled													
Baseline	20.75	14.50	15.12	15.23	15.87	16.46	17.07	17.56	17.99	18.41	18.97	19.41	20.01
Scenario	20.75	14.50	15.12	15.84	16.67	17.00	17.27	17.59	18.02	18.50	19.10	19.53	20.10
Change	0.00	0.00	0.00	0.61	0.80	0.55	0.20	0.03	0.03	0.09	0.13	0.12	0.09
% Change	0.00%	0.00%	0.00%	3.98%	5.07%	3.33%	1.19%	0.17%	0.18%	0.52%	0.66%	0.62%	0.46%
U.S. FARM PRICE, $/cwt rough													
Baseline	8.09	6.68	6.48	6.66	7.11	7.44	7.56	7.53	7.60	7.76	8.00	8.21	8.43
Scenario	8.09	6.68	6.48	7.01	7.39	7.52	7.53	7.53	7.65	7.85	8.08	8.28	8.50
Change	0.00	0.00	0.00	0.35	0.28	0.08	-0.02	-0.00	0.05	0.09	0.08	0.07	0.07
% Change	0.00%	0.00%	0.00%	5.31%	3.96%	1.10%	-0.29%	-0.04%	0.72%	1.11%	1.05%	0.89%	0.82%
U.S. BREWERS PRICE, $/cwt milled													
Baseline	7.41	8.08	8.18	8.31	8.54	8.86	9.19	9.50	9.78	10.07	10.38	10.72	11.06
Scenario	7.41	8.08	8.18	8.31	8.61	8.94	9.24	9.51	9.78	10.08	10.40	10.74	11.09
Change	0.00	0.00	0.00	0.00	0.07	0.08	0.04	0.01	0.00	0.01	0.02	0.02	0.02
% Change	0.00%	0.00%	0.00%	0.00%	0.79%	0.88%	0.48%	0.13%	0.04%	0.12%	0.20%	0.22%	0.20%
U.S. RETAIL PRICE, cents/lb milled													
Baseline	45.59	41.55	39.09	39.35	40.82	42.56	44.20	45.44	46.44	47.54	48.97	50.29	51.84
Scenario	45.59	41.55	39.09	40.21	42.39	43.67	44.59	45.46	46.49	47.74	49.25	50.56	52.05
Change	0.00	0.00	0.00	0.86	1.57	1.12	0.39	0.02	0.04	0.20	0.28	0.27	0.22
% Change	0.00%	0.00%	0.00%	2.20%	3.84%	2.62%	0.88%	0.03%	0.09%	0.42%	0.58%	0.54%	0.42%

AGRM 1995 U.S. FARM INCOME IMPACT PROJECTIONS
BENOMYL WITHOUT ALTERNATIVE

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Production Market Value (million $)													
Baseline	1263	1321	1155	1236	1318	1383	1407	1396	1395	1415	1451	1484	1520
Scenario	1263	1321	1155	1253	1325	1349	1347	1337	1345	1371	1405	1435	1468
Change	0	0	0	17	7	-34	-60	-59	-49	-44	-45	-49	-52
% Change	0.0%	0.0%	0.0%	1.4%	0.5%	-2.5%	-4.2%	-4.2%	-3.5%	-3.1%	-3.1%	-3.3%	-3.4%
Government Program Cost (million $)													
Baseline	785	757	817	856	740	648	588	564	534	491	421	377	342
Scenario	785	757	817	731	607	573	566	558	519	466	396	365	331
Change	0	0	0	-125	-134	-75	-22	-6	-14	-25	-25	-12	-11
% Change	0.0%	0.0%	0.0%	-14.6%	-18.1%	-11.6%	-3.7%	-1.0%	-2.7%	-5.1%	-5.9%	-3.1%	-3.2%
Total Income (million $)													
Baseline	2048	2078	1972	2092	2058	2031	1995	1960	1929	1906	1872	1861	1862
Scenario	2048	2078	1972	1984	1932	1922	1913	1895	1865	1837	1802	1800	1799
Change	0	0	0	-108	-127	-109	-81	-65	-64	-69	-70	-61	-63
% Change	0.0%	0.0%	0.0%	-5.2%	-6.2%	-5.4%	-4.1%	-3.3%	-3.3%	-3.6%	-3.8%	-3.3%	-3.4%
Returns Above Variable Costs ($/acre)													
Baseline	399.33	293.87	296.66	305.00	293.87	277.90	257.41	240.03	227.09	214.78	195.90	182.51	172.23
Scenario	399.33	293.87	296.66	271.40	254.68	245.45	236.18	225.26	212.42	197.53	177.66	167.34	156.37
Change	0.00	0.00	0.00	-33.61	-39.20	-32.45	-21.23	-14.77	-14.67	-17.24	-18.24	-15.17	-15.86
% Change	0.00%	0.00%	0.00%	-11.02%	-13.34%	-11.68%	-8.25%	-6.15%	-6.46%	-8.03%	-9.31%	-8.31%	-9.21%
Consumer Impact (million $)	0	0	0	-80.83	-64.39	-18.76	4.97	0.66	-12.66	-19.84	-19.38	-17.02	-16.04
Producer Impact (million $)	0	0	0	17.06	6.93	-34.25	-59.59	-59.32	-49.45	-43.89	-45.33	-49.10	-52.22
Net Impact (million $)	0	0	0	-63.77	-57.45	-53.01	-54.62	-58.66	-62.11	-63.73	-64.71	-66.12	-68.26